TECHNOLOGY DEPT.

POWER PLANT ENGINEERING

THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY

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1944

Pennsylvania Edison Adds 31,250 kw. Unit
Selecting And Applying Motor Controls
Progress In Turbogenerator Practice
Evaporative Cooling
Fontana Dam Hydro Plant Of TVA

For Other Articles See Contents Page 5

NOVEMBER
1944

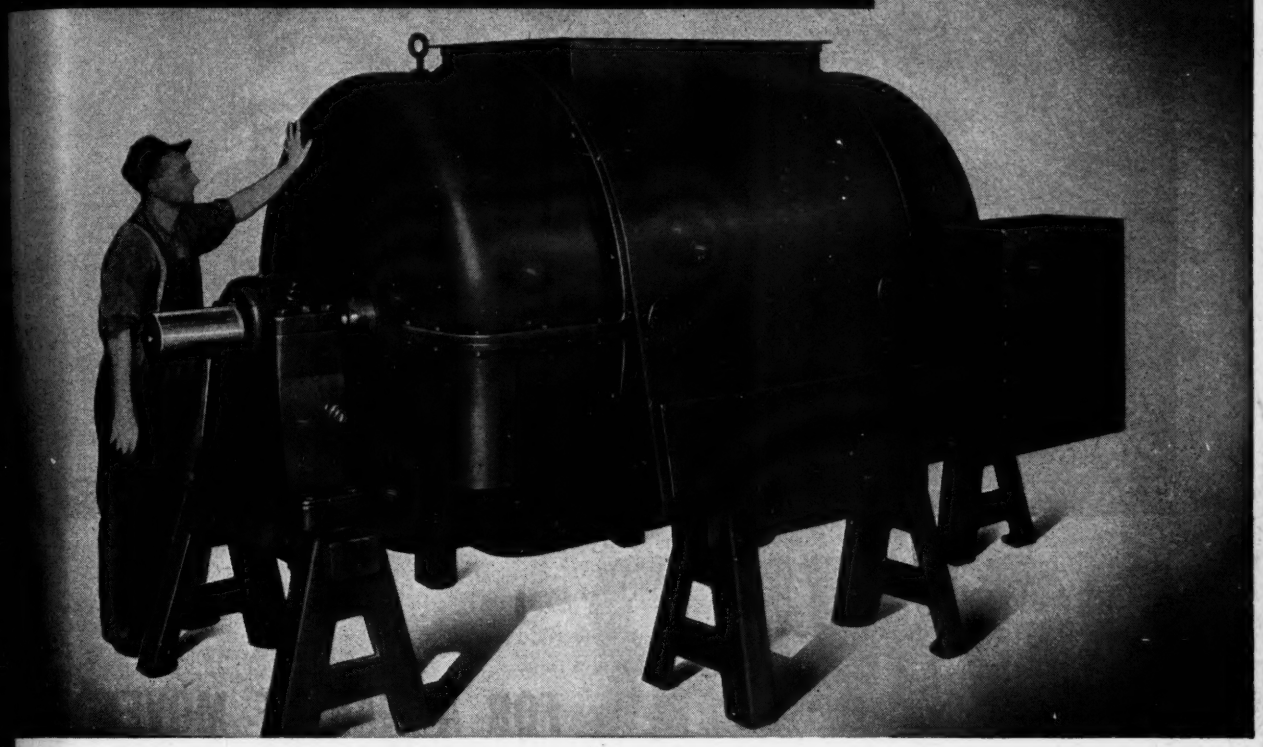
Heap big motors!

When you have a motor 17 feet in outside diameter, you've got something really big. These huge babies are built to drive tankers for the Maritime Commission. Here are the data: a 6600 hp, 93 rpm, 4000 volt, 3 phase, unity power factor synchronous motor —total weight of motor and shaft over 58 tons.

Size isn't everything, but — a shop that can build motors like these, can do a real job on any motor.

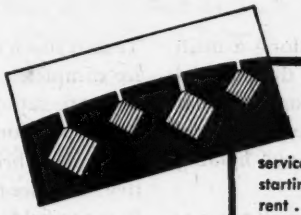
ELLIOTT

...and heap fine motors too!



Another big one — a 2-pole synchronous job. It's 4000 hp, largest of its kind we have built to date — largest we've heard of, in fact. This one drives a gas exhauster on a vital war job.

These big high speed synchronous and induction motors that Elliott is building are getting themselves talked about, with favor, everywhere. If you are looking for that kind of motor it might be worth while to talk it over with Elliott engineers.



Many of these motors have
ELLIOTT DIAMOND CAGE CONSTRUCTION

An exclusive Elliott development, used where required by service conditions. It provides: High starting torque . . . Low starting current . . . Reduction in leakage of flux in synchronous motors . . . Most desirable ratio of cage resistance and most favorable relation of cage reactances . . . Close nesting of bars without sacrifice of strength . . . Eliminates looseness between rotor stack and bars . . . Exceptional strength, and stiffness of tip of stack . . . Aids quiet operation.

L-759

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STORED on spur tracks along a main rail line, locomotives by the hundred await use in liberated territory . . . their dependable power a guarantee of rapid movement of supplies for our fighting men.

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Contents, November, 1944

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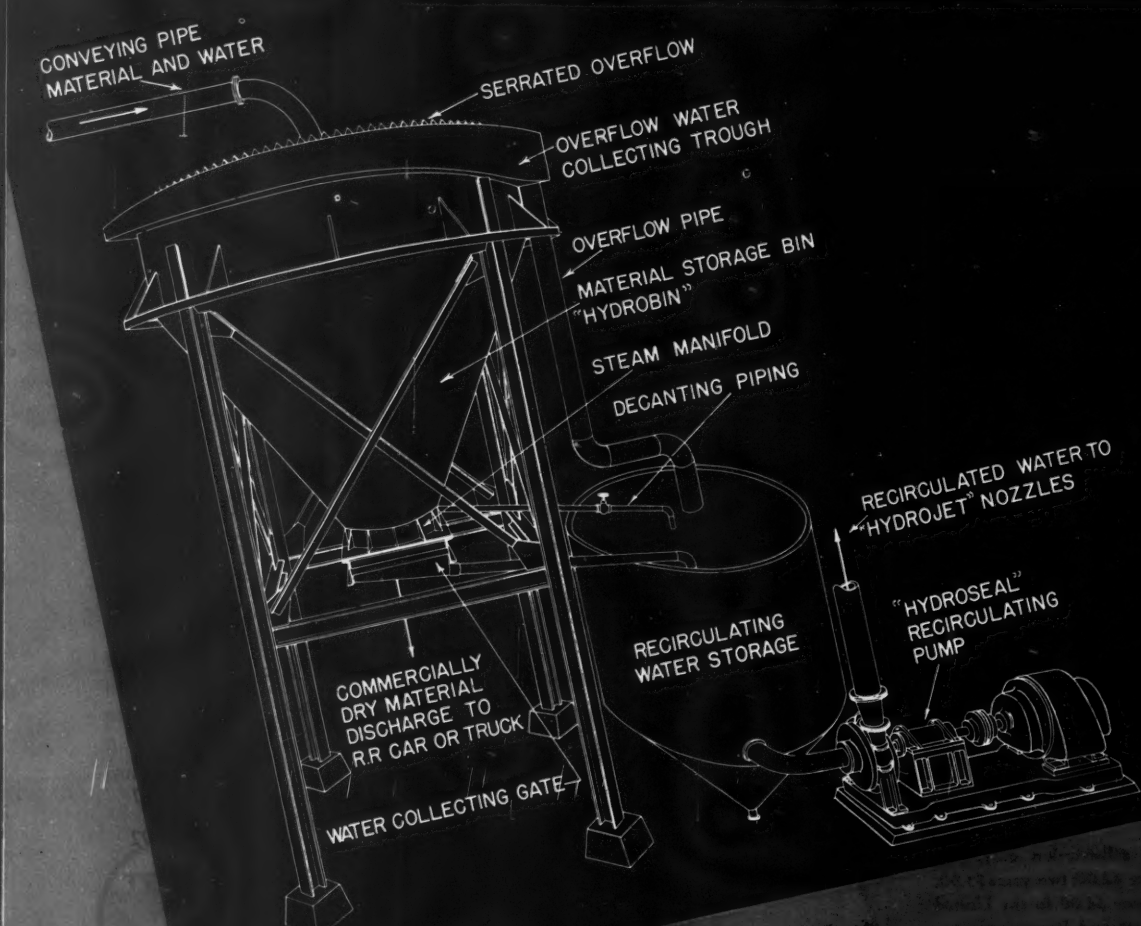
Ashes Pumped WET—Delivered DRY

Ash and dust laden water enters the Hydro-Bin at the top; the water being removed by the overflow trough at the top, decanting elements at the sides and a water collecting gate at the bottom of the bin. Commercially dry refuse remains in the bin, for unloading into cars or trucks. Water removed from the bin can pass into a sewer or it may go to a storage tank, as illustrated, for recirculation through the Hydrojet System of Ash Removal or the Hydrovac System of Dust Removal. Hydroseal Pumps are used for pumping refuse into the bin and for recirculation of water. . . . The Dewatering Hydro-Bin is equipped with a steam manifold around the discharge gate, to insure operation in sub-freezing temperatures. Our nearest representative will gladly give you full information about this and other methods of refuse disposal available where Hydrojet and Hydrovac Systems are used.

Dewatering HYDRO-BIN



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FRONT LINES

"SYMPATHOMIMETIC AMINES" may lead to a chemical compound that "heightens the speed of intellectual processes" and at the same time serves as an excellent "hang-over pick-me-up" may through research now under way develop new significant medical uses, Dr. Maurice L. Tainter, director of research of the Winthrop Chemical Co., Inc., disclosed in a recent paper before the American Chemical Society. Amphetamine and desoxyephedrine are two chemical compounds of these amines, Dr. Tainter pointed out, which serve as "stimulants of the nervous system." (We assume he could pronounce 'em; we don't even try.) "The stimulation that is produced," he declared, "apparently consists in a heightening of the speed of intellectual processes and a diminution in the awareness of fatigue with no definite alteration of motor functions. The main clinical applications of these reactions are in overcoming narcolepsy (the uncontrollable desire for sleep), and as a general 'pick-me-up' in conditions of depression after alcoholic excesses, or in the depressed states of some psychoses." Better than a prairie oyster?

GAS TURBINE aircraft engines of as much as 10,000 hp will be available for giant aircraft within the next decade, according to G. W. Vaughan, president of the Wright Aeronautical Corp., of Paterson, N. J., who has announced recently that the 25-year-old company which developed the air-cooled radial engine will produce aviation turbines as well as conventional type engines in the post-war period. Development of a turbine of this power would mean more energy in one unit than in all four engines of the mightiest bomber now in use, the Boeing B-29 Superfortress with four Cyclones totaling 8,800 hp. At a press conference marking the 25th anniversary of Wright Aeronautical, Mr. Vaughan indicated that research and development programs are now under way on turbine units. Marking one of the biggest advances in aviation since the radial engine first appeared, one type of Wright gas turbine will be an engine of high power, built to drive a propeller, as contrasted with the turbine units of basically similar principle used in jet propulsion planes.

RELATIVE POROSITIES OF MATERIALS are tested by an apparatus for which a patent has just been issued to Stuart H. Hahn and Robert H. Judson and assigned to The B. F. Goodrich Co. The porosity is tested by drawing air or gases through the material and indicating the rate of flow. So small and compact that it can be easily lifted and transported with one hand, the apparatus consists of a vacuum chamber in contact with the material to be tested, a constant-speed power-driven fan for evacuating air from the vacuum chamber, an outlet port for emitting the air, a pressure gage for measuring the degree of partial vacuum in the chamber and indicating this on a fixed scale. This scale may be graduated in absolute units or made to show the relative porosities of two or more pieces of material.

IF A NEW TYPE MIRROR comes into general use everyone will have cause to be suspicious of every mirror on a wall. If one of these mirrors is set in a wall between two rooms and both rooms are equally lighted the "mirror" is transparent from both sides, reports Ohmite News. If one room is brighter than the other then a person in the first room can be seen from the second room but sees only reflections of himself.

REINFORCING our October Front Lines comment on post-war jobs, a fine analysis of Jobs After the War, by Sumner H. Slichter, appears in the October issue of the Atlantic Monthly. After a careful analysis of the existing needs for consumer goods, both durable and consumable, Professor Slichter says that "the economy which will follow the war for some years may be called a 'catching-up' economy." Following this, the country will have to shift to a self-sustaining economy and this will be more difficult than the shift from war-time to peace-time production. The test of a reasonable rate of economic progress might be 15 per cent more output for each man, woman and child every 10 yr. This is a slower rate of increase than the country has achieved in any decade except the thirties, when virtually no progress was made. Let us keep clearly before us these great potentialities of our economy. Awareness of them, concludes Professor Slichter, will help us keep our sights high; it will stimulate our confidence in our power to achieve; it will help us retain and strengthen the spirit of pioneering and innovation.

USING the same "black light" employed by FBI and OPA agents in detecting counterfeit money and ration coupons, as well as by industry to determine the difference in various metals, chemical ingredients and textiles, physicians are uncovering many hidden symptoms of disease, according to observations on patients at Bellevue Hospital, New York, made by Drs. Maurice J. Costello and Louis V. Luttenberger and published in the current issue of the New York State Journal of Medicine. The light used was one developed in the laboratories of the Hanovia Chemical & Mfg. Co., Newark, N. J.

SILVER may now be deposited electrolytically on aluminum or aluminum alloys by a simple method, known as the Preplate Process; a development of the Technical Processes Division of Colonial Alloys Co., Philadelphia, Pa. Silver deposits of considerable thickness can go directly onto the aluminum surfaces, or follow a copper, nickel, zinc or cadmium deposition. Torsion, heat, corrosion resistance and weathering tests have shown up well. Adherence is good. Because of its high rate of conductivity, silver plating onto light weight aluminums, opens up vast possibilities in the electrical equipment, appliance, transportation and communications fields.

THE PLANNERS for tomorrow are dusting off another old one but it may be worth thinking about. Do you remember, in the pages of the Scientific American and Popular Mechanics, back about 50 yr ago and in other writings of that time looking into the future, the many references to moving sidewalks for carrying pedestrians at relatively high speeds through our great cities? This was not merely an inventor's dream, for a moving sidewalk of this type was actually in operation at the Columbian Exposition in Chicago in 1893. One of the principal factors that has held it back has been the lack of a suitable flexible material from which it could be constructed at a reasonable cost. The planners are looking now, however, at some of the very long belt conveyors that have been handling great masses of crushed stone, coal, and other basic materials for industry during the past two or three years with great success and high economy. Here, they say, may be the answer to the moving sidewalk of the future.

DEPARTMENT OF LIBERAL EDUCATION in the House Organs in 15 Minutes a Day:—Coal Stripping in Ohio, a well illustrated story showing how the coal industry strives to increase production; The Du Pont magazine, September-October, 1944; E. I. du Pont de Nemours & Co., Inc. * * * Digest of Sheave Maintenance, giving wire rope and sheave groove tolerances; Ropeology, October, 1944; The Macwhyte Co. * * * A Glance at the Light Metals, an interesting tabulation of their tensile strengths, ductility, thermal and electrical conductivity and other properties; The Synchroscope, October, 1944; Detroit Edison Co. * * * Why Body Styles Influence Trap Selection, with diagrams that show why; Flash Steam Used for Storage Type Hot Water Heater; also a thrilling one act play entitled Give Me Back My Money, or, Kiss the Traps Goodbye, They Didn't Save Any Steam; Armstrong Trap Magazine, No. 3, 1944; Armstrong Machine Works * * * Minerals Go to War, well illustrated story of how they are produced and processed; The Valve World, September, 1944; Crane Co. * * * Why and how crankshafts vibrate and what can be done about it, a 14-page highly technical article, well illustrated; Sulzer Technical Review, No. 4, 1943; Sulzer Bros. Ltd.; Winterthur, Switzerland * * * Army Engineers in Greenland, with splendid pictures showing the conditions under which they carried out some of the biggest building jobs of the war; Conveying Bulk Materials with Air; Compressed Air Magazine, September, 1944 * * * Cast Crankshafts Meet Severe Operating Requirements; Nickel Cast Iron News, 3d quarter 1944; International Nickel Co. * * * Post-war Farms, showing how the March of Time is dramatizing farm electrification; Rural Electrification News, September, 1944; Rural Electrification Administration * * * Operating Gas Lines by Remote Control; P. G. & E. Progress, September, 1944; Pacific Gas & Electric Co.

RETIREMENT of James A. Moyer from the directorship of the Massachusetts Department of University Extension, after 29 yr of service, throws a spotlight on one of the most significant developments in adult education in this country. All engineers, of course, are familiar with Mr. Moyer through his two best known textbooks, "Power Plant Testing," and "Elements of Engineering Thermodynamics," the latter by the famous team of Moyer, Calderwood, and Potter. But few of them know that he served so long in the field of University Extension. The most recent development of the Massachusetts Extension University was the correspondence method it worked out for permitting men in the armed services all over the world to take its courses. At the present, of course, the government agencies are co-operating in this work, paying one-half the instruction cost for soldiers and sailors. This year 30,000 students are taking the extension courses, but the system is yet to see its greatest development, in the opinion of Mr. Moyer. All engineers, we are sure, will join us in congratulating Mr. Moyer on a good job well done.

SENATOR JAMES E. MURRAY of Montana has recently introduced a bill into the Congress providing for the creation of a Missouri Valley Authority to undertake the unified development of power, irrigation, navigation and flood control projects in the Missouri basin area. The proposed authority would follow the general pattern of the Tennessee Valley Authority, would be headed by a board of three directors appointed by the President but accountable to the Congress, and would be required to pay 5 per cent of its gross revenues to the affected States.

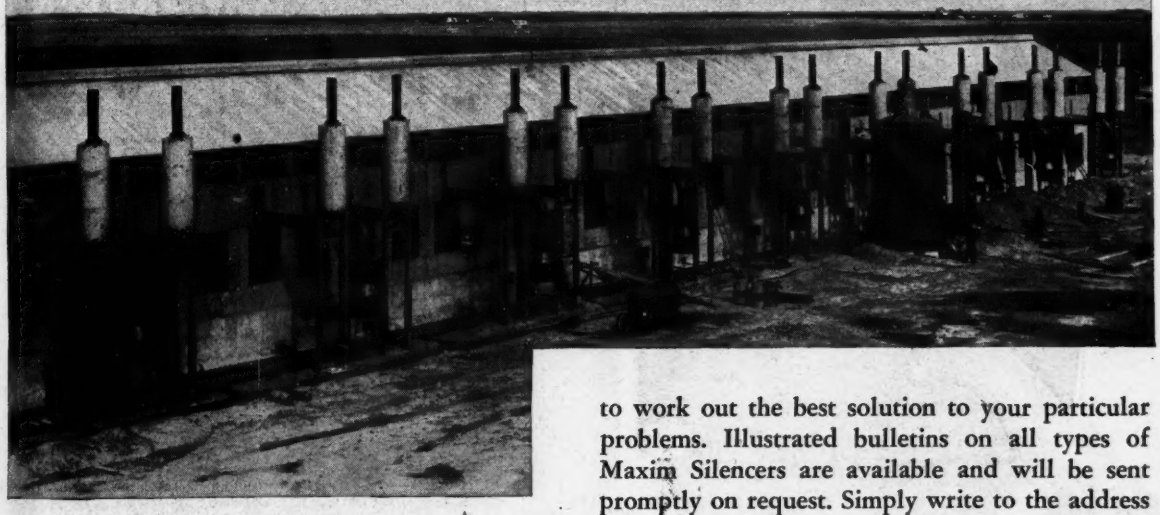
A NEW AUTOMATIC domestic heating device burning anthracite has recently been developed by Anthracite Industries, Inc., at its research laboratories at Primos, Pa. It consists of a screw type coal feeder supplying coal to a small cylinderical water-cooled furnace for which draft is supplied by an induced draft fan discharging to the chimney. The water in the jacket surrounding the furnace is circulated by a pump through a hot water radiation system to heat the house, and it is stated that the unit can also be adapted to steam or warm air systems. Some engineers, on looking at the cross-section of the unit, have thought that its operation resembles very closely that of a gas producer, because the incoming combustion air passes first through the discharging ash, then through the burning fuel bed, and then through the incoming raw coal before being discharged by the induced draft fan to the chimney. If that were true, very poor combustion would be obtained. The designers of the unit, however, point out that because of the way anthracite burns, no secondary combustion area over the fuel bed is required, that the total cross-section is so small that combustion gases cool rapidly and do not give producer reactions and that proof of good combustion in the unit is given by relatively high CO_2 values in the outgoing combustion gases. This unit is, of course, being planned for postwar manufacture by private industry. For those sections of the country that have always preferred anthracite for house heating purposes, it may prove extremely interesting.

ONE TON OF RIBBON ICE a day is the capacity of of each of the small self-contained refrigerating plants supplied for use of the armed forces in the Pacific area. They furnish ice for ice bags, permit refrigeration anesthesia, cool water and soft drinks, make ice cream and in general are one of the war's biggest boons to advance base and mobile hospitals and wounded GIs.

V-E DAY (Victory in Europe Day) will see the end of all war-time control over electric utilities. The OWU has laid out a program under which its Order U-1 will be revoked on that date. All other controls affecting utility operations are expected to be removed also, except for a few items which may then be still in short supply. At this writing, it has not been decided whether Order L-94 covering certain power pooling interconnections will also be withdrawn, but there is a possibility that it will be allowed to remain in force until the progress of the Japanese war and the return to large scale civilian production are clear. Practically all L and M orders issued by WPB will be revoked on V-E Day with specific control retained only on those materials likely to remain tight after Germany's defeat. Chairman J. A. Krug of WPB stated recently that from four to five million men will be released from direct and indirect war work within a year after V-E Day and that large quantities of steel, copper, and other materials will become available enough to raise civilian production to the levels of 1939. These steps, together with the proposed modifications in manpower controls to facilitate transfer of workers from curtailed war production to civilian production, will present industry with a production picture entirely different from the present one.

RADAR would make it impossible for an enemy to launch more than one or at the most two robot bombs against a big city like New York, according to electrical manufacturers. The only way it could be attempted would be by a submarine carrier, which would have to surface to launch the bomb, whereupon patrol planes and ships would spot it instantly by radar. Thereafter its chances would be below absolute zero.

MAXIM SILENCERS ON ALL COMPRESSOR STATIONS OF LONGEST GAS PIPE LINE SINCE 1932



The longest gas pipe line since 1932, built by Tennessee Gas and Transmission Co., extends from Corpus Christi, Texas to Cornwall Station, West Virginia, a distance of 1265 miles.

Along the line seven compressor stations maintain the pressure in the 24-inch pipe which is designed for an operating pressure of 750 pounds. All of these stations are completely equipped with Maxim Silencers as shown above on the Bernard, Texas, station.

Wherever there is need for silencing, on engine exhaust, compressor intake, blowers, steam or air discharge, Maxims can be counted on to give long, trouble free service. Maxim engineers will be glad to work out the best solution to your particular problems. Illustrated bulletins on all types of Maxim Silencers are available and will be sent promptly on request. Simply write to the address listed below, giving details of the job you want to do.

* * * * *

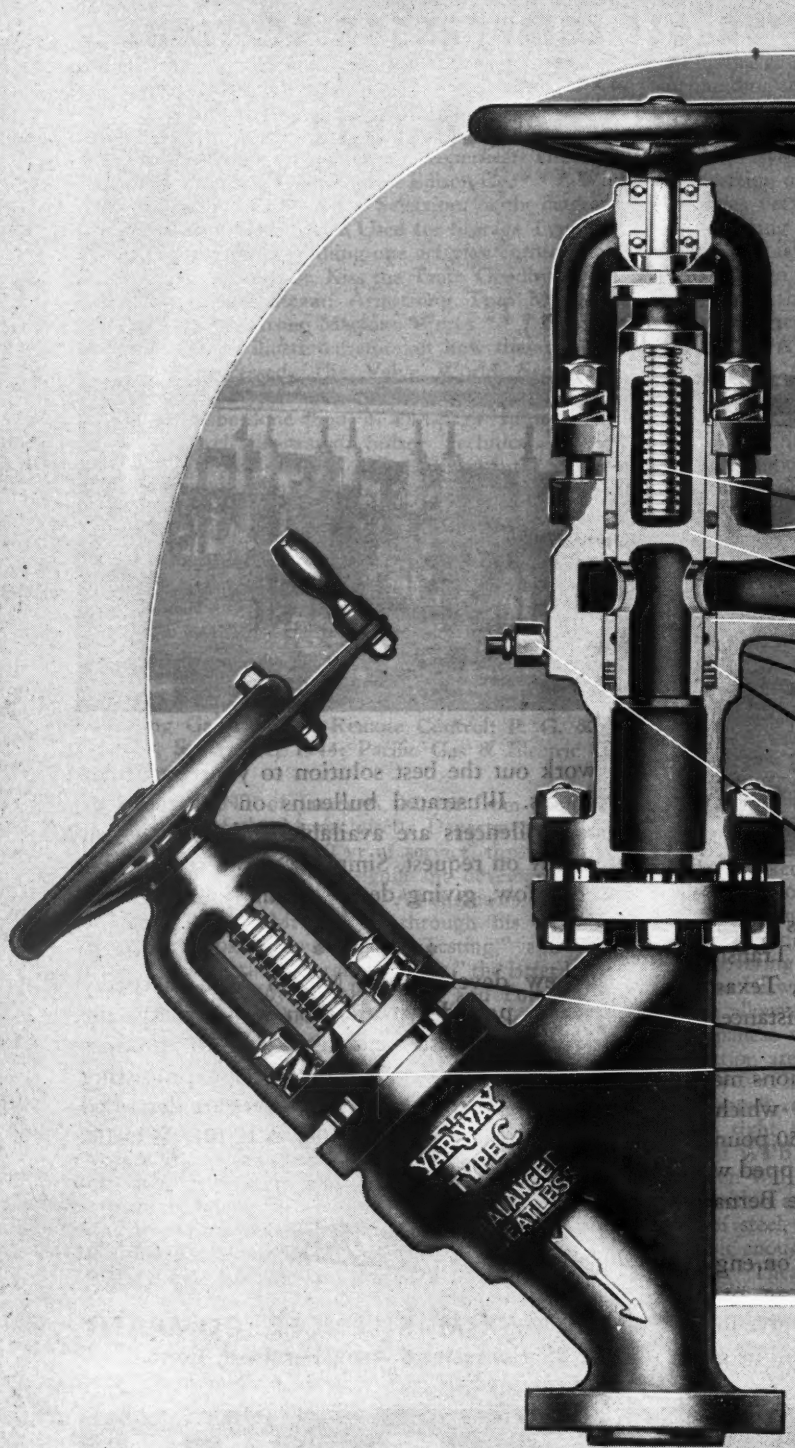
A new development, Maxim Heat Recovery Silencers, provide in addition to silencing, the recovery of waste exhaust heat to produce steam or hot water for heating or processing operations. Heat Recovery Silencers are described in Maxim Bulletins WH-100, WH-101, WH-102 and WH-103.

ARMY E NAVY

THE MAXIM SILENCER COMPANY
89 Homestead Ave., Hartford, Conn.

MAXIM

The Seatless Blow-Off Valve . . .



BECAUSE ★ ★ ★

"No Seat to Score,

Heat-treated steel stem.

Nitralloy Plunger and lower Follower Gland. Brinell hardness 1100 (upper Follower Gland, chromium plated steel).

Cast Steel Body and Yoke.

Laminated packing ring with stainless steel reinforcing inserts.

Alemite lubrication of Plunger (also for ball thrust bearings in yoke).

Yoke Springs maintain required pressure on packing at all times.

Yarway Type C Seatless Tandem Blow-Off Valve (angle valve Fig. 3910, straightway valve Fig. 3912) for pressures up to 600 lbs.

YARWAY

"Standard" in Over 12,000 Plants

Note ample space for free flow with no projections or pockets to accumulate scale or sediment.

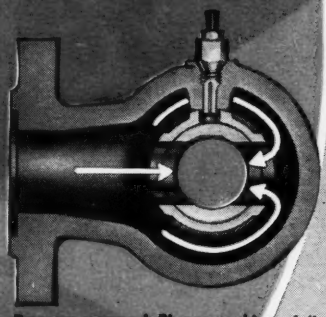
Wear and Clog with Mud, Scale and Dirt"

More than a quarter century ago, Yarway introduced their Seatless Blow-Off Valve and said—"No seat to score, wear and clog with mud, scale and dirt." Power plant operators, harassed by continuous trouble and expense with conventional valves—welcomed the Yarway as the answer to their troubles . . . purchased them, watched them, standardized upon them. And the Yarway Seatless design, in a relatively short time, became the most widely preferred blow-off valve.

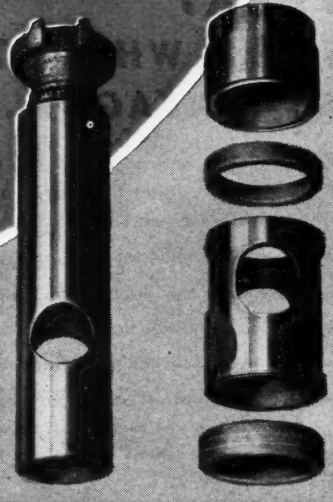
Today, after a quarter century of service, it still holds that distinction. Sound fundamental design . . . coupled with continuous mechanical and metallurgical research anticipating ever-new service requirements . . . makes the highly improved Yarway Seatless Valve of today just as good insurance against blow-down trouble and expense in today's plants as it was in the plants of twenty-five years ago.

There is a Yarway Valve for every pressure and purpose. Write for Catalog B-424 for pressures up to 400 lbs. Catalog B-431 for higher pressures.

YARNALL-WARING COMPANY
114 Mermaid Ave., Philadelphia 18, Pa.



Pressure surrounds Plunger making a fully balanced valve, easy to operate regardless of pressure.



Nitralloy Plunger and lower Follower Gland, and laminated packing with stainless steel inserts, add years to valve life.

BLOW-OFF VALVES

The TERRY

TERRY
SOLID WHEEL TURBINE
ADVANTAGES . . .

— The blades and the wheel (see above) are in one piece so that there are no parts to become loose or work out.

— The blades have large clearances.

— The blades are double rim protected.

— End play will not damage the blading.

— It is impossible for the blades to foul.

— The power producing action of the steam in the wheel takes place on the curved surfaces at the back of the buckets and, therefore, close blade clearance is not necessary.

— As the only function of the blades is to form a series of pockets, wear of the blade edges is of little consequence and does not materially affect the horsepower or efficiency. The important part of the bucket is the back, or bottom, which is a solid forging.

— The Terry wheel will withstand abuse that would wreck any built up wheel.

THE TERRY STEAM TURBINE CO.

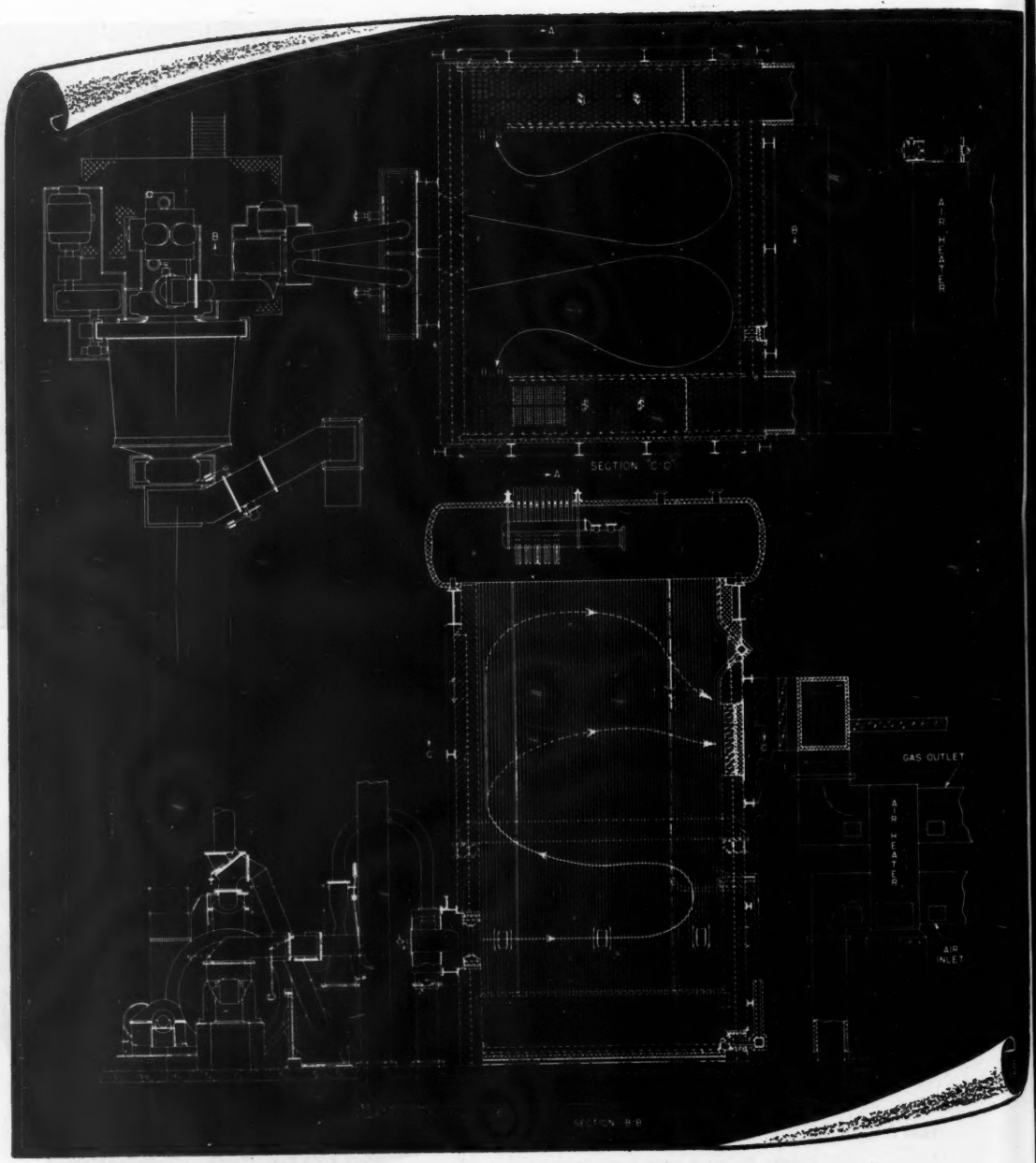
Wheel Turbine

At right—
Action of steam in Terry wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket in which its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

T-1147

TERRY SQUARE - HARTFORD, CONN.

Reverse Firing



FW FOSTER

Reduces . . .

✓ CARBON LOSS

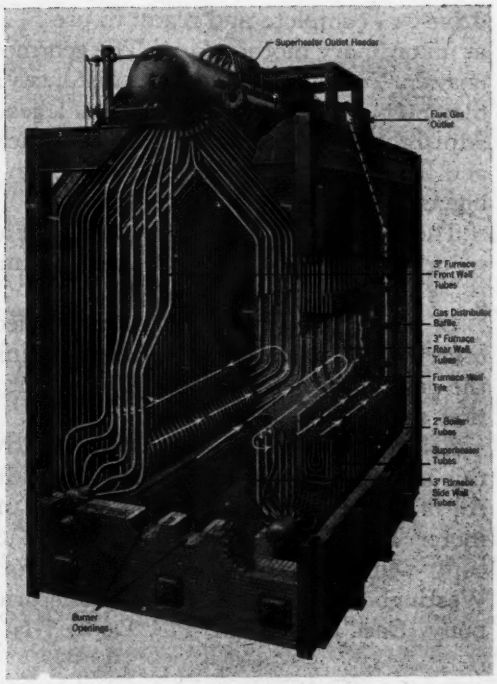
✓ ASH CARRIED *INTO* BOILER

✓ SLAGGING *OF* BOILER

AND SUPERHEATER

Reverse Firing

—GASES TWICE TRAVEL THE LENGTH OF THE FURNACE—IS A PATENTED FEATURE USED IN THE "S-A" STEAM GENERATOR



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GEARMOTORS SIMPLIFY SELECTION

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The gearmotor combines prime mover and speed reducer in a single compact unit . . . motor and gears are *matched* to the job.

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Ask your Westinghouse representative about this and many other basic gearmotor advantages. All of these are discussed in detail in new gearmotor handbook, "Gearmotor Applications". A copy will be sent on request. Ask for B-3218. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., Dept. 7-N. J-07219

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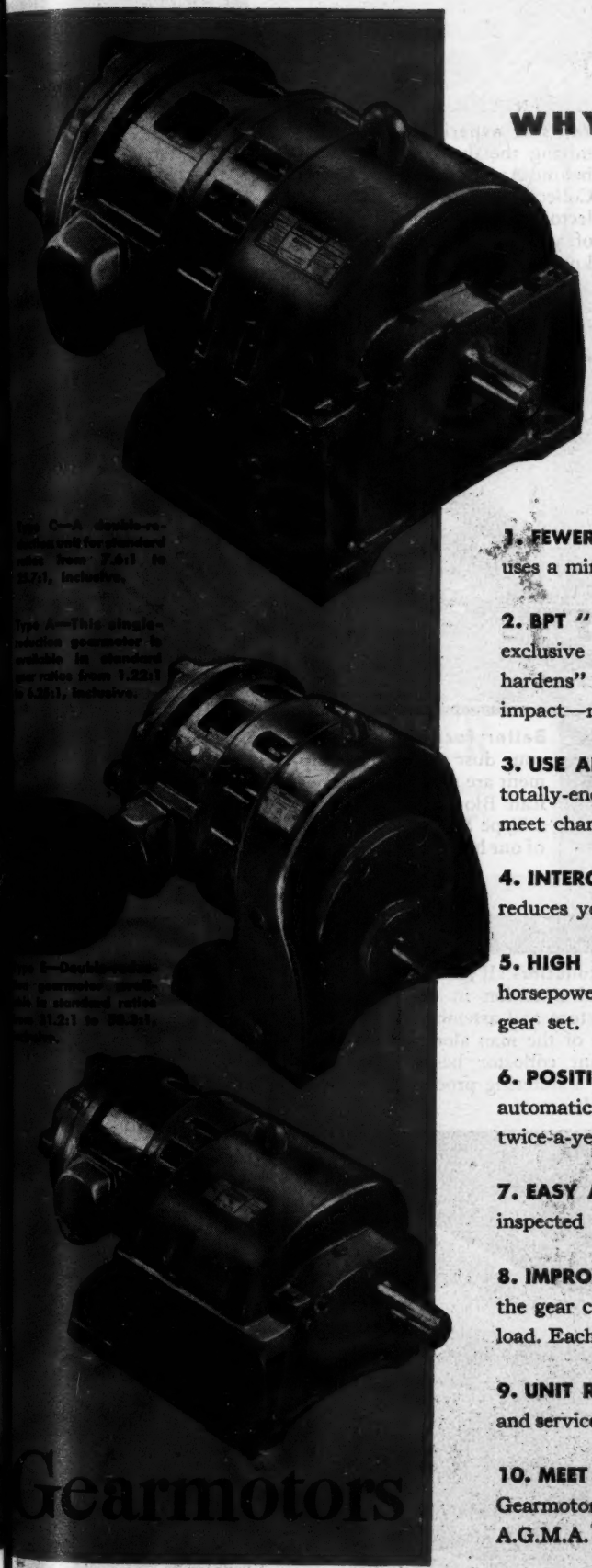
REASON NO. 1—GEARMOTORS SAVE SPACE

Third of a series sponsored by Westinghouse to promote the use of gearmotors.

The New Westinghouse G

PLANTS IN 25 CITIES . . . OFFICES EVERYWH



WHY USE WESTINGHOUSE GEARMOTORS?

. . . check these 10 good reasons

1. FEWER PARTS TO WEAR. The simple, efficient, design uses a minimum of moving parts.

2. BPT "TOUGH-HARD" GEARS AND PINIONS. This exclusive Westinghouse heat-treating method "tough-hardens" teeth for maximum resistance to shock and impact—means longer wear.

3. USE ALL WESTINGHOUSE MOTOR TYPES—open . . . totally-enclosed . . . splashproof . . . explosion-proof—to meet changes in operating conditions quickly and easily.

4. INTERCHANGEABILITY OF PARTS between unit types reduces your parts' replacement stock by 40%.

5. HIGH EFFICIENCY of gearing parts assures full motor horsepower at output shaft : : : only 2% power loss per gear set.

6. POSITIVE LUBRICATION of gears and bearings by automatic splash system reduces probable maintenance to twice-a-year change of oil.

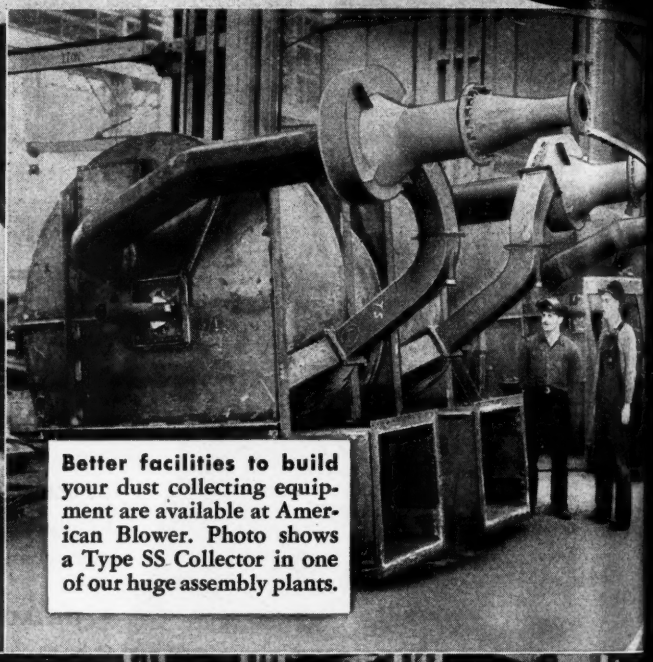
7. EASY ACCESSIBILITY. Gearing parts can be readily inspected or easily removed to make gear ratio changes.

8. IMPROVED FOUNDATION STABILITY. Feet are under the gear case . . . placing support next to the gearmotor load. Each foot is reinforced by external ribs.

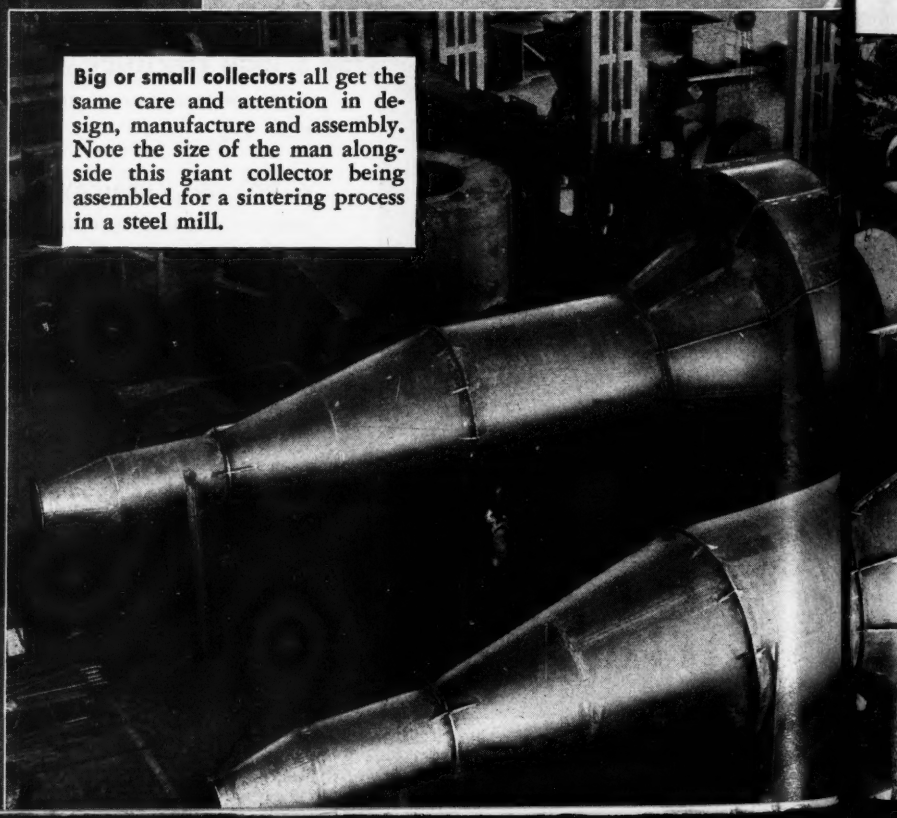
9. UNIT RESPONSIBILITY for design : : : manufacture . . . and service. Westinghouse builds both motor and the gears.

10. MEET A.G.M.A. STANDARDS. The new Westinghouse Gearmotors are specifically designed and built to meet A.G.M.A. standards . . . easy to order and match to the job.

Years of experience in minimizing the dust nuisance are behind American Blower Dust Collectors. This Type D Collector was installed a number of years ago in a nationally known cement plant.



Better facilities to build your dust collecting equipment are available at American Blower. Photo shows a Type SS Collector in one of our huge assembly plants.



Big or small collectors all get the same care and attention in design, manufacture and assembly. Note the size of the man alongside this giant collector being assembled for a sintering process in a steel mill.

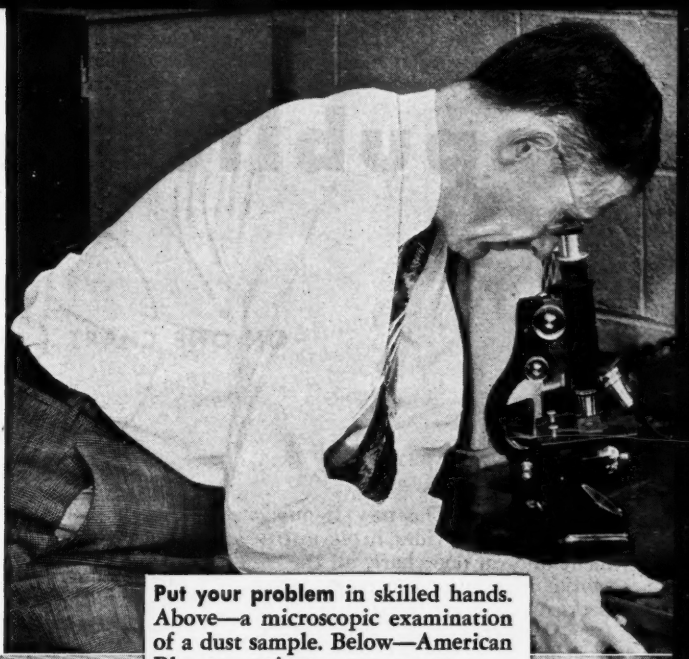
American Blower

DUST COLLECTORS

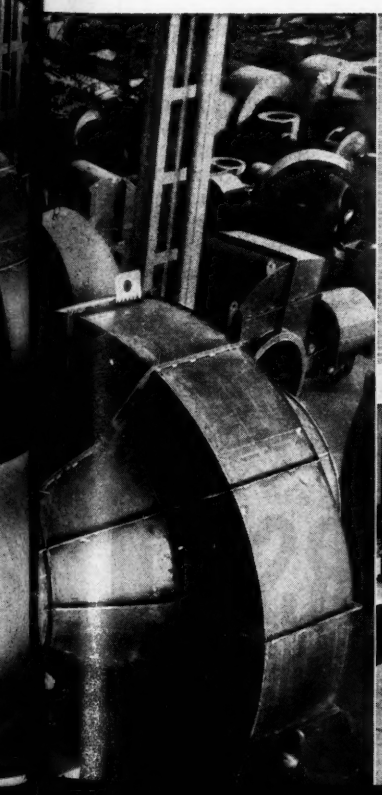
In dust collectors, this fact stands out. In the last 20 years, tests on more than 4100 distinctly different materials have been carried out in the American Blower Testing Laboratories. These tests include microscopic investigations, screen analyses, and collector performance. This unprecedented background of experience insures your satisfaction with American Blower Dust Collectors.

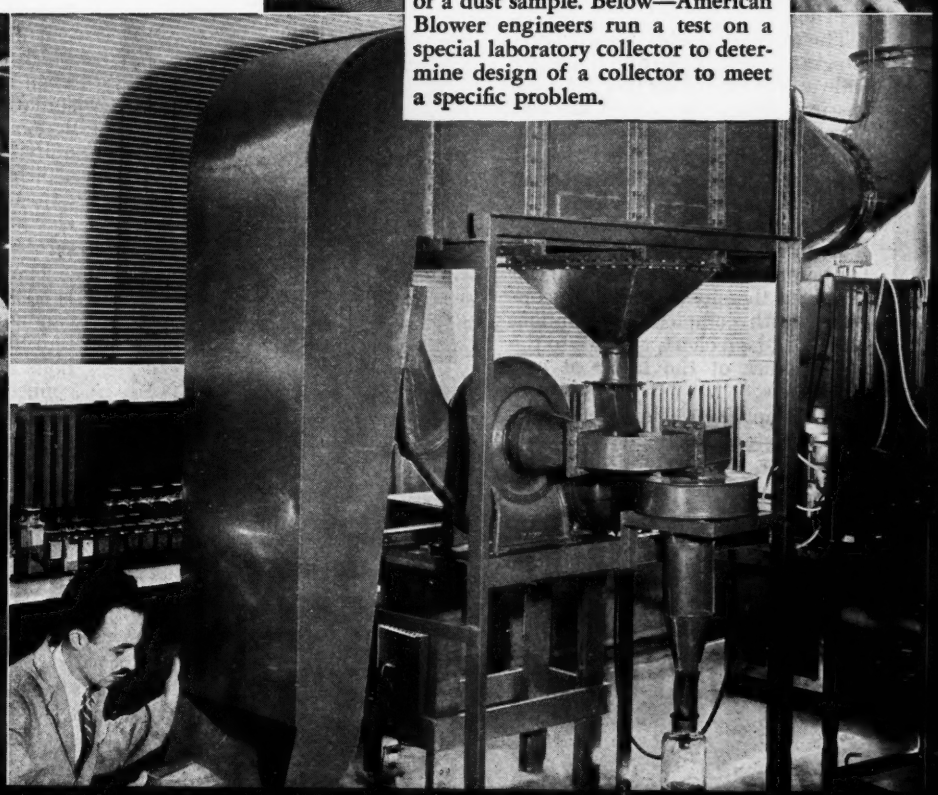
AMERICAN BLOWER

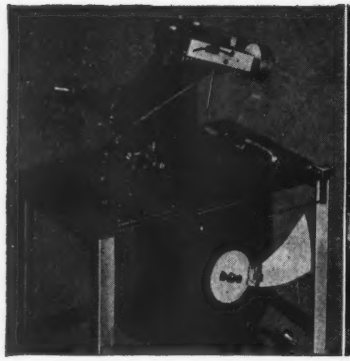
AMERICAN BLOWER CORPORATION, DETROIT, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONT.
Division of American Radiator & Standard Sanitary corporation



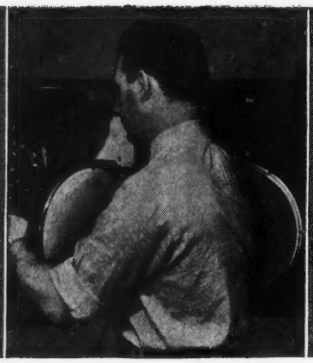
Put your problem in skilled hands. Above—a microscopic examination of a dust sample. Below—American Blower engineers run a test on a special laboratory collector to determine design of a collector to meet a specific problem.



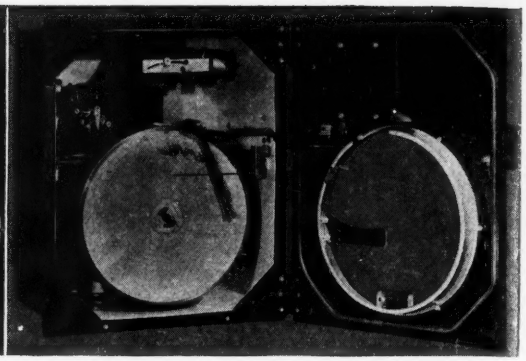




Meter assembled as one unit on rack ready for calibration.



Meter assembly can be easily removed from the case.



Meter with door open showing accessibility of all adjustments and working parts.

Republic Boiler Meter

ON ONE CHART ○
STEAM FLOW
AIR FLOW
TEMPERATURE
OR PRESSURE

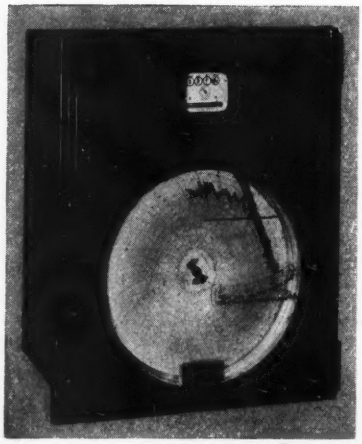
★ The new Republic Boiler Meter provides, in one instrument and on one chart, all the essential information concerning boiler performance regardless of the size or type of boiler, kind of fuel or method of firing.

The meter indicates, records, and integrates steam flow from the boiler and records rate of air flow for combustion. When the correct amount of air for maximum combustion efficiency is being supplied the air flow pen will record coincident with the steam flow pen, regardless of the load being carried by the boiler.

A third pen recording flue gas temperature (or steam pressure) can be added thereby providing the operator with complete information, on one 12-inch chart, relative to the performance of the boiler at any given time.

The Republic Boiler Meter consists of a standard Republic electric steam flow recorder and integrator and an oil sealed, bell type air flow element.

The air flow element consists of an oil sealed bell in a sealed chamber. The motion of the bell is transmitted through a diaphragm seal. This arrangement permits the use of a single bell—the high pressure being applied to the top of the bell and the low pressure under the bell. This arrangement also excludes air and dirt from the oil. The motion of the bell is transmitted to a cam system which extracts the square root, or when adjusted for a particular installation, compensates for chimney action and variable excess air requirements. The air flow pen is attached to the cam system with an adjustable linkage which permits changing the steam flow air flow ratio as conditions may require.



The entire operating mechanism is housed in a rugged steel case and can be easily removed as a single unit by merely loosening two anchor bolts and disconnecting the two air connections. The meter may be either wall mounted or flush mounted on a steel panel. *Write for Bulletin No. 420.*

REPUBLIC FLOW METERS CO.

2224 DIVERSEY PKWY. CHICAGO 47, ILLINOIS

THE BACK COVER OF "THE ARMSTRONG STEAM TRAP BOOK"

The Armstrong Guarantee

EVERY Armstrong Trap is guaranteed to be free from defective workmanship or material, to function perfectly, to fulfill all claims in every respect and to give complete satisfaction.

Armstrong Machine Works
Three Rivers, Michigan

MORE than thirty years of successful manufacturing, sales and service experience stand back of the Armstrong Guarantee. During this time, the Armstrong Machine Works has steadfastly recognized the fact that the good will of the users of a product should be the manufacturer's foremost consideration.

It naturally follows from this basic policy that the product is so designed, built and installed as to be satisfactory and profitable to the user. Further, a strong effort is maintained to keep relations with customers on a human and pleasant basis as well as in accordance with good business practice. Catalogs and advertising material are carefully scrutinized to eliminate any exaggerations or misleading statements.

Representatives are carefully chosen, not only for their responsibility and experience in the steam specialty field, but also for their respect for our sales policies. In Armstrong trap selling, merit of the product is placed far ahead of personality, acquaintanceship, or reciprocity. To avoid complications and discrimination, we insist that a one-price policy be maintained. It is our intention that every customer shall receive the very lowest price offered to any buyer of the same size and number of Armstrong traps.

Our representatives are able and willing to give service in the selection and operation of Armstrong products. We stand squarely behind them in this work and furnish them our full support. We want every user to feel free to call on us for information or assistance at any time. Our interest in our product does not cease with the sale. It becomes all the more keen. Only through such an interest can we safeguard our biggest asset—the good will of Armstrong trap users.

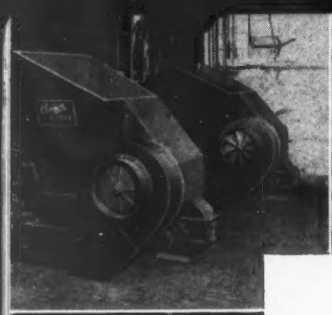
CATALOG ON REQUEST

The 36 page Armstrong Steam Trap Book is a useful aid in trap selection, installation and maintenance. It includes charts, tables, data and diagrams pertaining to condensate drainage and Armstrong Steam Traps. Write for a copy.

Armstrong Machine Works
310 Maple Street, Three Rivers, Michigan

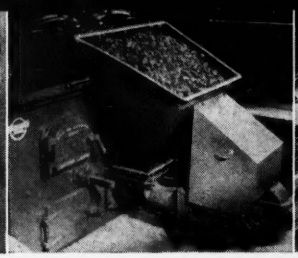
ARMSTRONG
INVERTED BUCKET
STEAM TRAP

ARMSTRONG STEAM TRAPS
for Power . . . Process . . . Heating

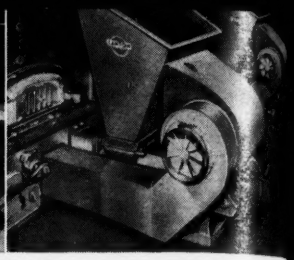


COPPERWELD STEEL CORP., WARREN, OHIO

ISALY DAIRY, NEW WILMINGTON, PA.



EUCLID ROAD MACHINERY CORP., CLEVELAND



U. S. NAVAL AIR FACILITIES, COLUMBUS, O.

MORIN HEIGHTS HOUSING PROJECT, WOONSOCKET, R. I.

GRIFFIN MANUFACTURING CO., BROOKLYN, N. Y.

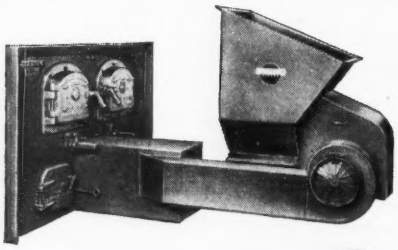
E. & W. DYEING CORP.

THERE ARE 54 TYPES AND SIZES OF

CANTON STOKERS

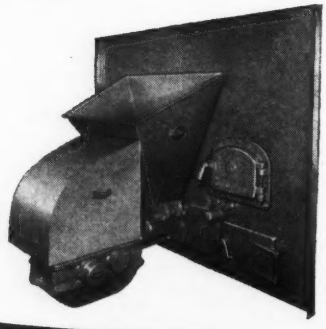
TO MEET *YOUR* REQUIREMENTS

HERE ARE THE THREE BASIC DESIGNS . . .



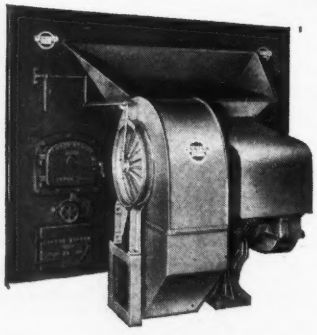
DURAFLEX

A wormfeed stoker for industrial and commercial installations with many features usually found only on ramfeed designs. Especially adapted to boilers developing up to 175 H.P., the Duraflex includes the refinements of a large active grate area, side ash dumping plates and zoned windbox. Separate fan drives and full furnace fronts are standard auxiliaries always available. Write for Bulletin No. 500.



LO-SET

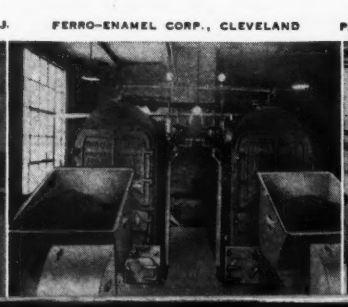
A compactly designed Heavy Duty Ramfeed stoker that has saved expensive furnace alterations and pitting for installation on scores of jobs. Built with a safety factor of 5 to 1 for developed loads of 450 H.P., the LO-SET will easily carry over-ratings up to 200%. Hi-Firebox heating and power boilers, designed to avoid furnace refractory, are successfully fitted with Canton Lo-Set Stokers. With Canton Synchronized Combustion Control, this unit will swing from 50% to 200% of boiler rating without manual attention. Request Bulletin No. 400.



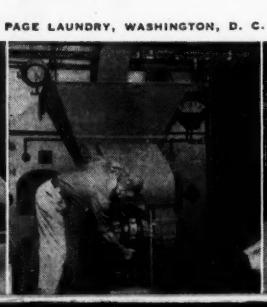
VULCAN

All Custom Built, these Stokers carry the heaviest industrial loads in continuous duty service. On either electric or steam drives they develop 800 H.P. or more, and with Canton Synchronized Combustion Control require no manual attention in shifting from 50% to 200% of rating. An extremely rugged, dust-proof gear box drives the Stoker through oversize bearings, gears, and sprockets with a safety factor of 5 to 1. Wearing surfaces are alloy-hardened and many parts are practically indestructible. Full information is offered in Bulletin No. 200.

PATERSON, N. J.

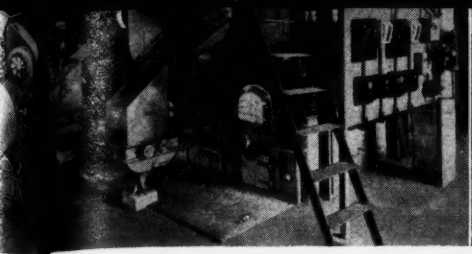


FERRO-ENAMEL CORP., CLEVELAND

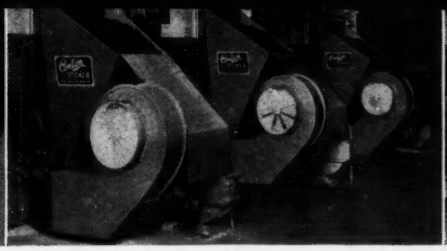


PAGE LAUNDRY, WASHINGTON, D. C.

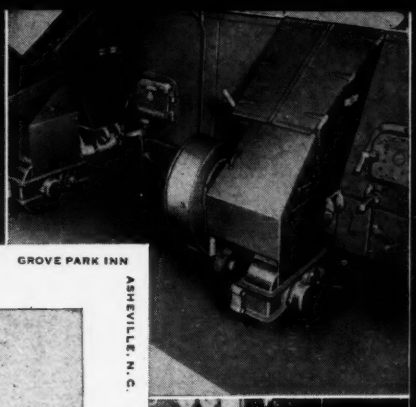
GESU CHURCH, CLEVELAND, OHIO



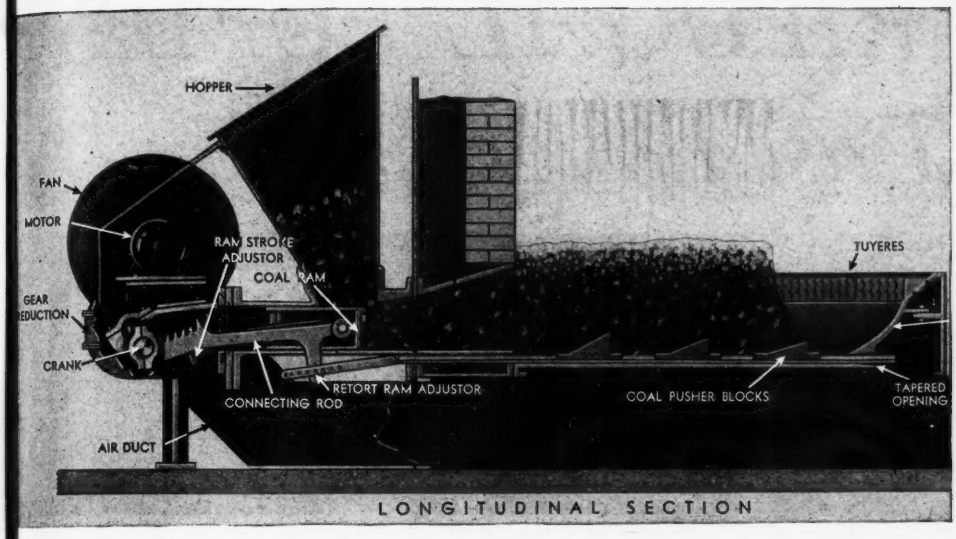
NORTON AND COMPANY, ALEXANDRIA, VIRGINIA



GENERAL HOSIERY COMPANY, FT. WAYNE, IND.



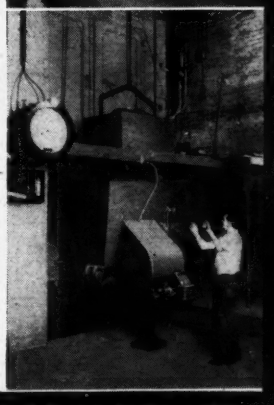
GROVE PARK INN
ASHEVILLE, N. C.



LONGITUDINAL SECTION

NEWBURGH AND SOUTH SHORE RAILWAY

VICTOR SILK HOSIERY, NEW BRITAIN, PENNA.

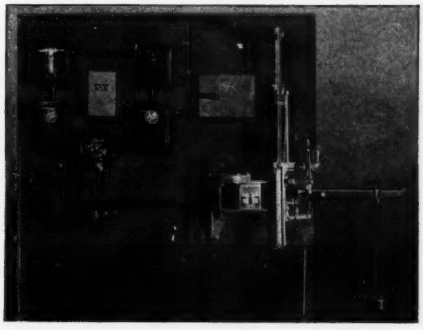


SHOREHAM HOTEL, WASHINGTON, D. C.

HIS X-RAY VIEW OF THE CANTON VULCAN STOKER *gives the inside facts on the simplified, powerful mechanism. Coal is loaded into V-shaped Hopper by hand or conveyor system, and falls by gravity down to Coal Ram. The Coal Ram is driven in a reciprocating action by the Crank, allowing coal to fall in front of Coal Ram on back stroke, and pushing it into Furnace on forward stroke. The highly efficient mounting of motor and gears delivers maximum power to the Coal Ram, which easily crushes wood, slate, and small pieces of foreign matter, feeds them into Furnace, and thus eliminates usual causes for stoppage. After passing through Throat, coal is distributed and levelled over the entire area of the Furnace by a Retort Ram with Pusher Blocks, adjustable for any kind or size of coal.*

CANTON STOKERS SAY IT WITH SERVICE—AND BACK IT UP WITH A FIVE YEAR GUARANTEE

CANTON STOKERS



Synchronized Combustion Controls-- For automatically varying coal feed, forced draft and boiler draft to follow efficiently steam demand.

All working parts not exposed to the fire are covered by a five year guarantee applying not only to defects, but actually wear itself. Only because these Stokers are built stronger at vital points, from superior materials, do they merit such a guarantee. A corps of travelling service engineers assists and advises Canton Stoker owners in securing best results.

Now IMMEDIATE DELIVERY FROM STOCK

TO REPLACE OIL, GAS, OR HAND FIRING EQUIPMENT

Send for Descriptive Literature and Cost Saving Facts

11 STORY RENKERT BLDG., CANTON, OHIO

HUMBOLDT DYE WORKS, BROOKLYN, N. Y.

CANTON STOKER CORPORATION

900 ANDREW PLACE, S. W., CANTON, OHIO

Gentlemen:

---Please send all descriptive literature at once

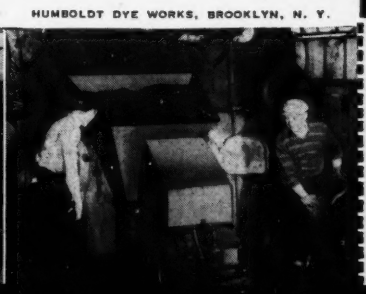
---Have a CANTON Engineer interview us immediately

Name _____

Company _____

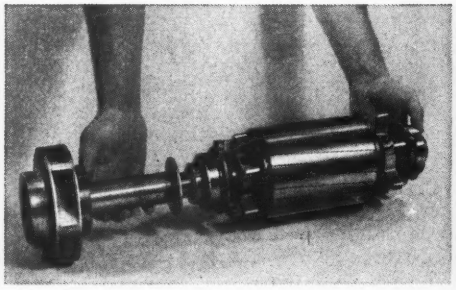
Address _____

City_____ State_____

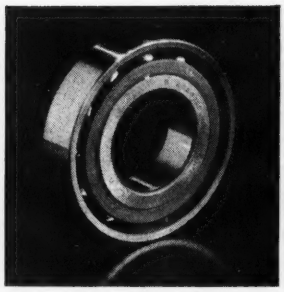


[PUMP TIPS FROM ALLIS-CHALMERS — ONE IN A SERIES]

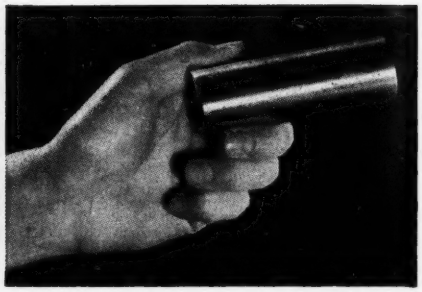
How to make CENTRIFUGAL PUMPS *Last Longer...*



1 WHEN YOU HAVE an A-C "Electrifugal" pump you don't have alignment problems, for *both* impeller and rotor are mounted on *one* shaft. However, most pumps are coupled to separate motors . . . and how well the two are kept in alignment has a lot to do with how long they last. For timely help, get your *free* copy of Allis-Chalmers' "Handbook for Wartime Care of Centrifugal Pumps".

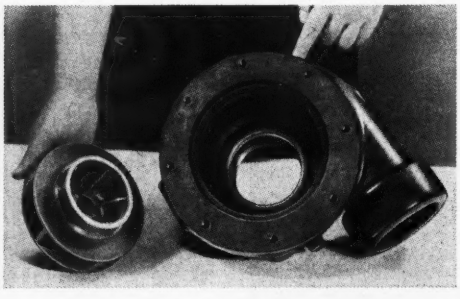


2 ALL BEARINGS AREN'T ALIKE. For example, while too much lubricant won't harm sleeve bearings, in anti-friction bearings it *promotes* friction. So play safe . use only the *right* amount of the *right* lubricant — as recommended by your manufacturer.



3 SLEEVES WEAR UNDULY when water seal piping is plugged, lantern ring displaced, water is dirty or stuffing box gland is drawn too tightly. By keeping a constant check on such sources of wear, sleeve life can be materially lengthened. For valuable tips on how to locate, how to remedy these and other pump troubles, consult the "Handbook".

4 THE KIND OF PACKING, and *how* you use it have a lot to do with how long your pumps last. Commonest cause of trouble traces back to lack of "know-how" in caring for stuffing boxes. A quick picture of the *how* and *why* of efficient packing can be found in the "Handbook".



5 AN OFTEN OVERLOOKED CAUSE of impeller and casing wear is cavitation. For if a pump's capacity, head and particularly, suction lift aren't figured properly, this enemy can eat vital parts away fast. Allis-Chalmers' "Handbook for Wartime Care of Centrifugal Pumps" contains a step-by-step method for figuring head, plus tables of losses to help you apply your pumps correctly.

TODAY, with pumps working harder than ever and replacements difficult to obtain, you can't afford to take chances on maintenance. That's why Allis-Chalmers has published its "Handbook for Wartime Care of Centrifugal Pumps".

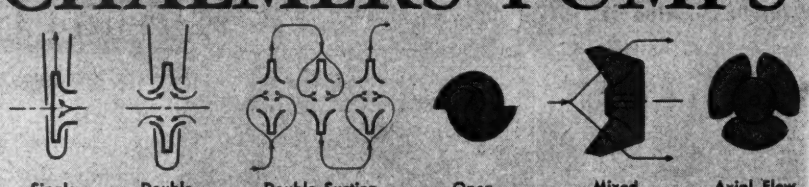
Write for your *free* copy of this valuable book today! It applies to *all* makes of pumps; contains *no* advertising.

And when you *do* need new pumps, look into the extra efficiency of A-C centrifugal pumps . . . the "Electrifugal", and all types for every purpose. ALLIS-CHALMERS, MILWAUKEE.

A 1776

ALLIS-CHALMERS PUMPS

Allis-Chalmers builds all types and variations of pumps shown at right. Capacities from 10 to 150,000 gpm—heads to 2500 lbs.

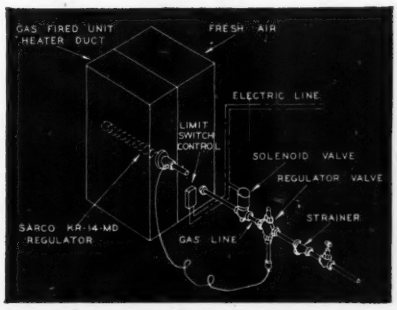


Who said "It can't be done"?

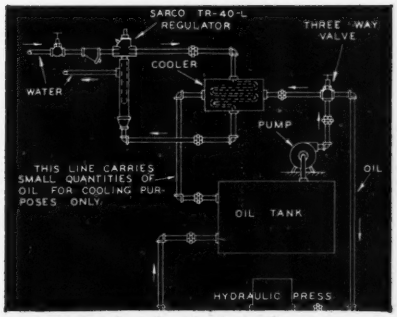
Selected for their unusual features, these hook-ups illustrate only a few of the many heating and cooling problems solved by Sarco engineers with inexpensive steam traps and temperature controls.

Sarco Temperature Control is available in many forms for equipment heated by steam, gas or oil, or cooled by water or brine. Ask for Catalog Nos. 600 and 700.

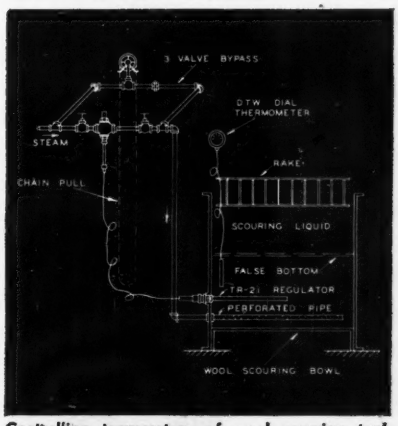
And don't overlook that inefficiencies in your process equipment may cause trouble in your heating system, particularly on cold days or around starting time. Ask for Catalog No. 250.



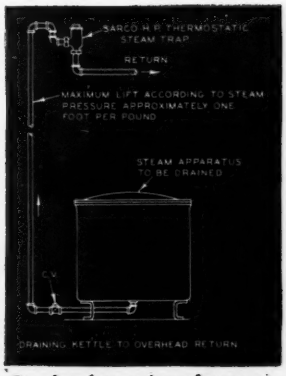
Sarco KR-14 control on gas fired unit heater.



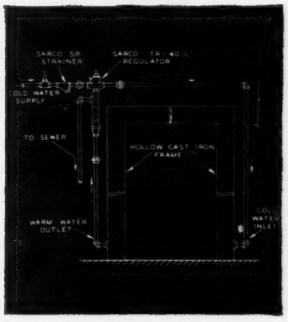
Controlling oil cooler for Hydraulic presses with Sarco TR-40L temperature control.



Controlling temperature of wool scouring tank with Sarco TR-21 temperature regulator.

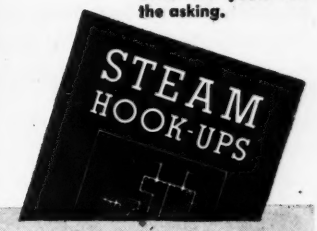

SARCO H.P. THERMOSTATIC STEAM TRAP
RETURN
MAXIMUM LIFT ACCORDING TO STEAM PRESSURE APPROXIMATELY ONE FOOT PER POUND
STEAM APPARATUS TO BE DRAINED
DRAINING KETTLE TO OVERHEAD RETURN

Overhead trapping of process equipment with Sarco No. 9 steam traps.



Controlling cooling water on furnace door frame with Sarco TR-40.

This Hook-Up book shows where and how you can increase production and save fuel. It's yours for the asking.



Ask SARCO First

45 45

SARCO COMPANY, INC.
475 FIFTH AVENUE
NEW YORK 17, N. Y.

Represented in Principal Cities

SARCO Saves Steam

SARCO CANADA, LTD., 85 Richmond Street, West, TORONTO, ONTARIO

HERE are three stoker designs — each developed to meet a different combination of requirements — which have demonstrated through actual survey, their complete suitability for 90% of all installations covered by C-E contracts of recent years.

These three simplify for you the problem of stoker selection to one of merely determining which type is the answer to your conditions of steam load, boiler design, and available fuels. With that done, you can be sure of reliable performance, durability, and low maintenance by entrusting your requirements to C-E. For embodied in each of these three designs are all the "know how" and experience gained from the installation of over 18,000 stokers of every type, above residence size, to serve approximately 5,000,000 rated boiler horse power.

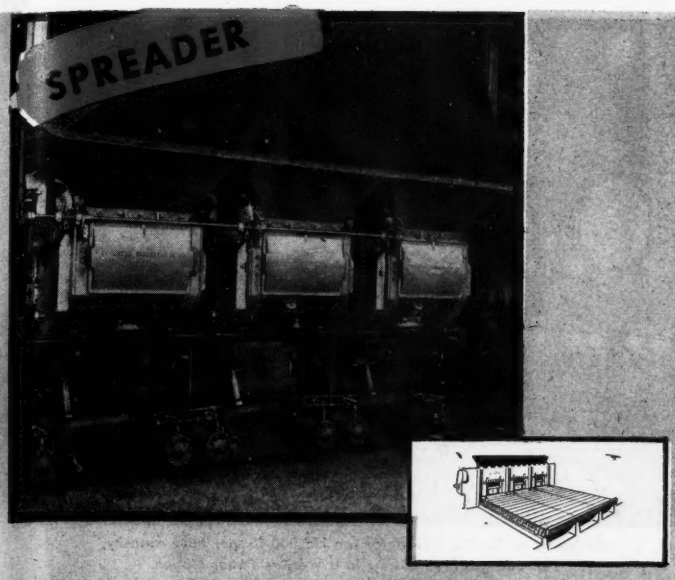
Comprehensive as these three types are, the C-E line includes other designs which round out the most complete line of stokers offered by anybody anywhere. So if your installation falls outside the 90% and within the remaining 10%, you will certainly find the answer to your needs among modern C-E designs of Multiple Retort, Travelling Grate, and Chain Grate Stokers.

Now is none too soon to plan for your new post-war installation or needed replacements. A C-E engineer will be glad to discuss your problem with you. A-829

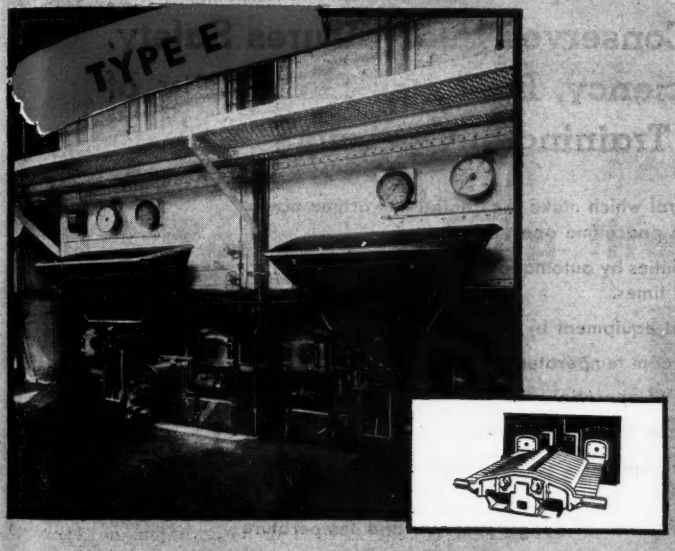
COMBUSTION ENGINEERING

200 MADISON AVENUE · NEW YORK 16, N. Y.

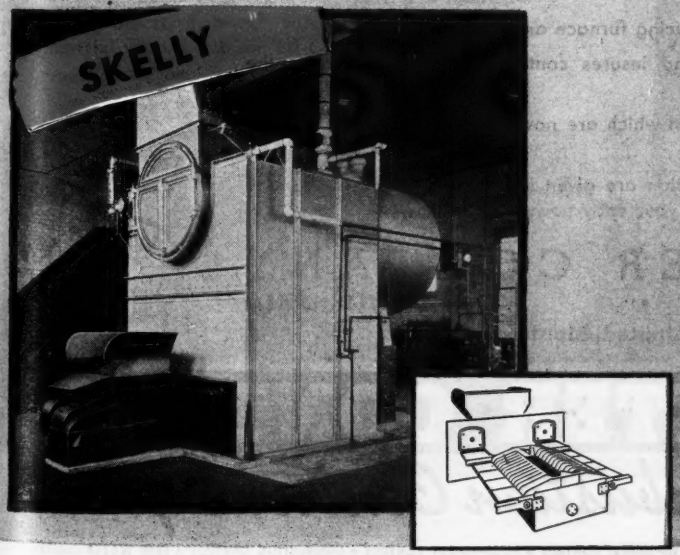
C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



Approximate Application Range — 150 boiler hp to largest units suitable for stoker firing. A simple, rugged stoker designed to burn a wider variety of fuels than any other type of mechanical firing. Hopper, feeding and distributing mechanism, variable-speed drive and motor are combined in a compact unit. Rotating spreader blades feed coal into the furnace in crisscrossing streams which assure uniform distribution. Fines are burned in suspension and the rest of the coal is burned on a grate — stationary or dumping type. Grate surface is zoned for regulating air admission and to facilitate cleaning.

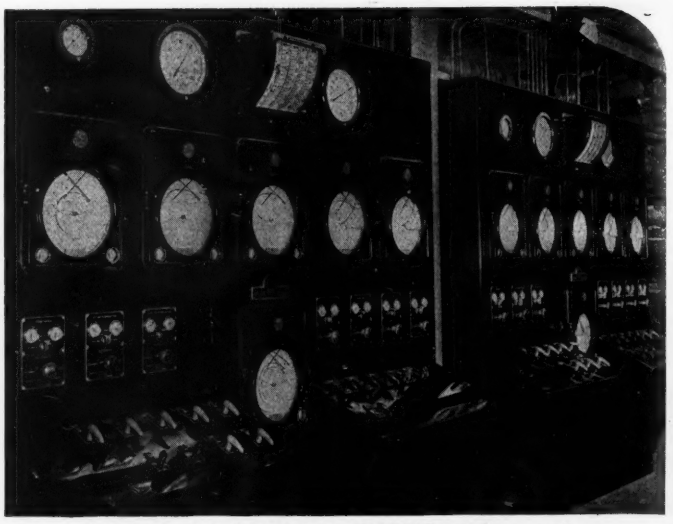


Approximate Application Range — 150 to 600 boiler hp. A single-retort, underfeed stoker designed to burn a wide variety of bituminous coals. Ram feed is supplemented by a reciprocating sliding bottom. Grate surface consists of hollow, air-cooled grate bars, alternately fixed and moving, to condition the fuel bed and assure its steady movement toward the dump trays. Air supply under zoned control with provision for introducing air over the fire. Steam or hydraulic drive.



Approximate Application Range — 20 to 200 boiler hp. A compact, self-contained unit offering all the advantages of underfeed firing. Moving grate bars assure lateral distribution of fuel and maintain a clean porous fire. Cantilever dump grates of non-avalanching type simplify ash removal. Integral forced-draft fan, with vortex inlet control, permits positive regulation of air-coal ratio. Sixteen rates of coal feed through variable-speed transmission. Automatic control is standard equipment. Timken bearing equipped. Alemite lubrication throughout.

ESSENTIAL IN *WAR* PROFITABLE IN *Peace*



Bailey Boiler Control Panels for two 135,000 lb. per hour capacity, oil and gas-fired boilers in a Western Power Station.

Bailey Boiler Control Conserves Fuel, Insures Safety, Increases Turbine Efficiency, Improves Continuity of Service and Simplifies Training of Operators

The same qualities of Bailey Boiler Control which make it essential in wartime power plant operation, make it profitable to use in peacetime operation.

It conserves fuel and fuel transportation facilities by automatically maintaining the correct fuel—air ratio for efficient combustion at all times.

It insures against accidents to operators and equipment by:

Accurate control of boiler water level, steam temperature and fuel—air ratio.

Interlocks to insure the proper sequence of operation.

Limiting devices to prevent operation under unstable conditions.

Alarms to warn operators of dangerous conditions such as high or low water level, flame failure, loss of air pressure, etc.

It increases turbine efficiency by supplying steam at design pressure and temperature at all times.

It improves the continuity of service by reducing furnace and boiler repairs.

It simplifies training of new operators and insures continuous economy during the training period.

These same qualities of Bailey Boiler Control which are now helping to win the war will help American industry to win the peace.

Suggestions for wartime boiler plant operation are given in our Bulletin No. 16 "How to Safely Stretch Steaming Capacity." Ask for your copy now. A-90

BAILEY METER COMPANY

1040 IVANHOE ROAD • CLEVELAND, OHIO

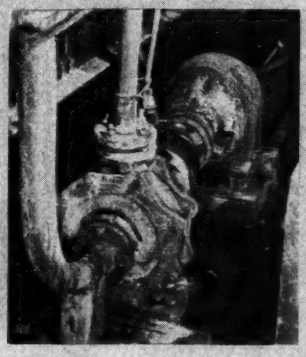
Bailey Meter Company Limited, Montreal, Canada

BAILEY METER CONTROL

The Complete Combustion Control System

BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPERHEAT CONTROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL

DOSE OF SALT

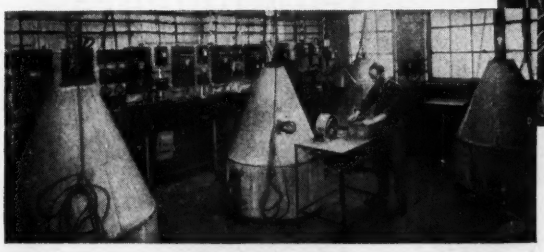


Encrusted with chemical salts, this Tri-Clad motor continues to drive a pump without breakdown of its insulation. In almost every industrial plant, motors are called upon to keep going under conditions which try their endurance to the limit. It may be in a plating room, or on an exhaust fan, or in a wet sub-cellar, or — as in this case — in connection with chemical processing. In emergencies, open motors may face conditions for which good engineering practice would require totally enclosed construction — conditions which tend to corrode the frame and attack the insulation. Endurance of Tri-Clad motors under such conditions results from tests like the one described below.

Salt-spray test of TRI CLAD motors gives assurance of long life in severe service

In this accelerated life test to determine the ultimate endurance of their insulation, the motors are operated to failure under one of the worst possible combinations of conditions. They are continually exposed to a 2% salt-water spray, while operating on a duty cycle of 3 minutes on and 37 minutes off. (These repeated voltage surges impose greater stress on the insulation than would continuous operation.) Tests are run on all new insulations developed, and as a production check on motors taken at random off the assembly lines. Because of their endurance under this severe test, among others, Formex* wire and Glyptal* bonding material were chosen for Tri-Clad insulation.

*Reg. U. S. Pat. Off.

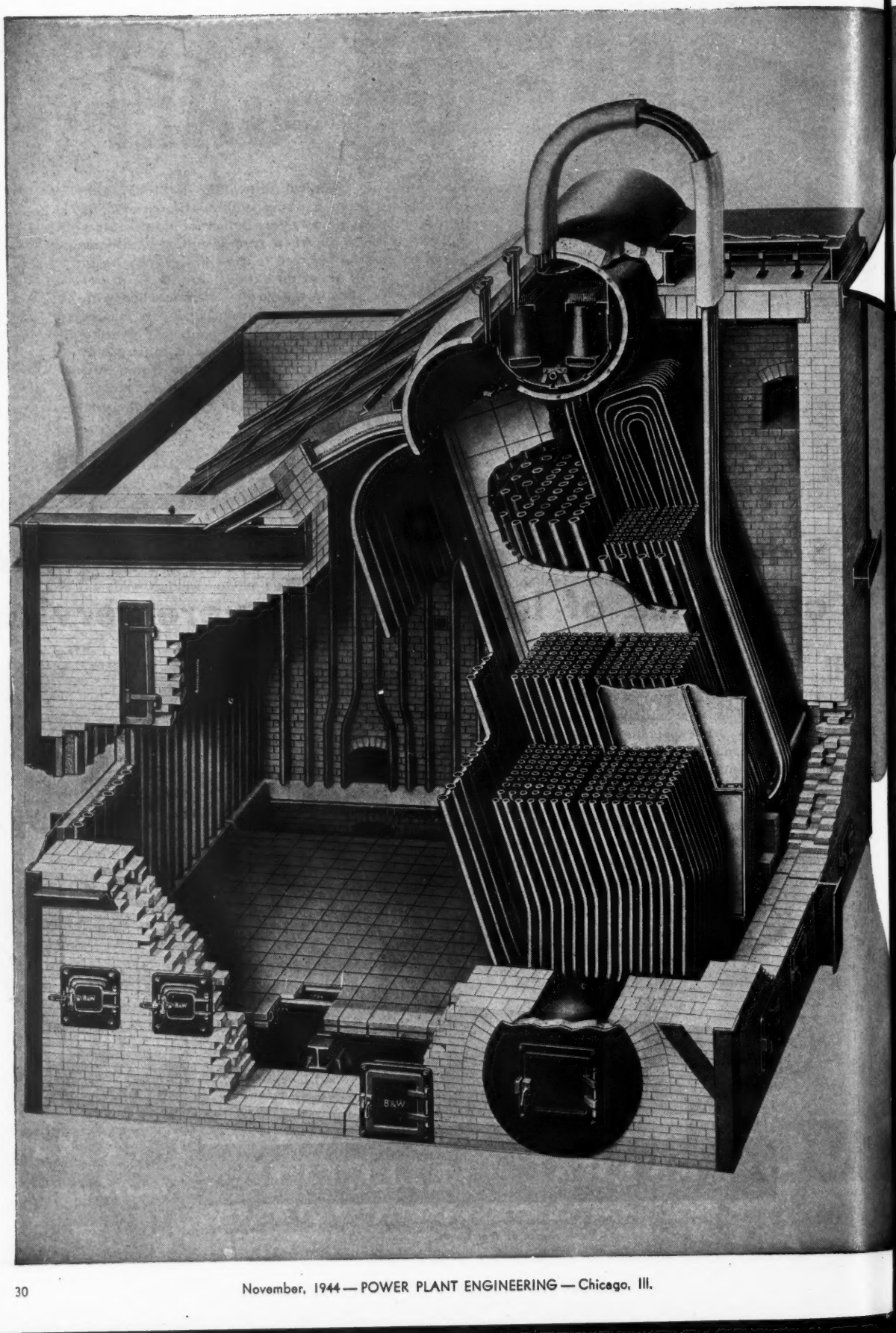


Left: Conical hoods cover the tanks in which these salt-spray tests are conducted.

GENERAL ELECTRIC

TRI CLAD MOTORS

Every week 192,000 G-E employees purchase more than a million dollars' worth of War Bonds.


B&W
B&W
B&W

THEIR DEPENDABILITY IS TWICE PROVED

In steel mills, chemical plants, refineries, ordnance plants, aircraft factories . . . wherever American industries are busy producing weapons of war, Babcock & Wilcox Integral-Furnace Boilers are supplying steam with utmost dependability and efficiency. Thoroughly tried and proved in pre-war services, these boilers are now further demonstrating their high availability for service and consistent reliability in a second set of tough assignments.

Faithful performance has been made certain in these B&W boilers by distinctive design and construction features such as:

1. Water-cooled furnace sidewalls and roof of the same durable stud-tube construction used in large central-station boilers.
2. Deep furnace, fired from one end, provides ample space for complete combustion.
3. Bare metal blocks cover and protect the tubes of the water-cooled furnace floor, and provide a surface readily cleared of ash.
4. Self-draining super heater design prevents accumulation of water in the tubes and assures steam flow through all tubes on starting up.
5. Tubes of the third bank, which is in the zone of coolest gases, act as downcomers, insuring rapid positive circulation at all loads.

From their additional war-time proving under unprecedented service conditions will come still better B&W Integral-Furnace Boilers to serve post-war industry.

THE BABCOCK & WILCOX CO., 85 LIBERTY STREET, NEW YORK 6, N. Y.

For additional information on B&W Integral-Furnace Boilers, send for Bulletin G-17-A.

BUY MORE WAR BONDS!

BABCOCK & WILCOX

G266 T

CLOSE UP OF DEAERATOR SHOWING VENT CONDENSER

SIDE VIEW, ONE OF MAIN DEAERATORS

It takes *Power*

to make Synthetic Rubber

and COCHRANE equipment to help produce that POWER efficiently

One of the most important plants in North America for the production of synthetic rubber has a power plant that is the last word in modern equipment. Among its important features are Cochrane Hot Process Water Softeners, with Cochrane Flow Meter control of acid feed, Cochrane Deaerators, Cochrane Continuous Blow-Off System, Cochrane Filters and Cochrane Multiport Relief Valves. The softeners consist of two units each with a capacity of 100,000 GPH. The softened water is filtered through 8 horizontal filters.

Acid proportioning is operated by a Cochrane flow meter, increase or decrease in flow causing a change in flow of acid. The softened and filtered water is deaerated in two Cochrane Deaerators, each with a capacity of 800,000 lbs. per hour. Another Cochrane Deaerator deaerates the water supply for the desuperheaters. A Cochrane continuous blow-off system is also installed, and Cochrane Multiport Relief Valves on the main exhaust header.

A complete description of this installation mailed on request.

DEAERATOR FOR DESUPERHEATER SUPPLY

AUTOMATIC SLUDGE BLOW DOWN ON SEDIMENTATION TANK, WITH MANUAL BY-PASS

FIG. 1000 COCHRANE MULTIPORT RELIEF VALVE ON MAIN EXHAUST HEADER

MAIN CONTROL PANEL FOR LIME, SODA ASH, SULPHURIC ACID, AND PHOSPHATE FEEDS, ALSO COMPLETE ALARM SYSTEM

AUTOMATIC CONTINUOUS TYPE ACID FEED EQUIPMENT

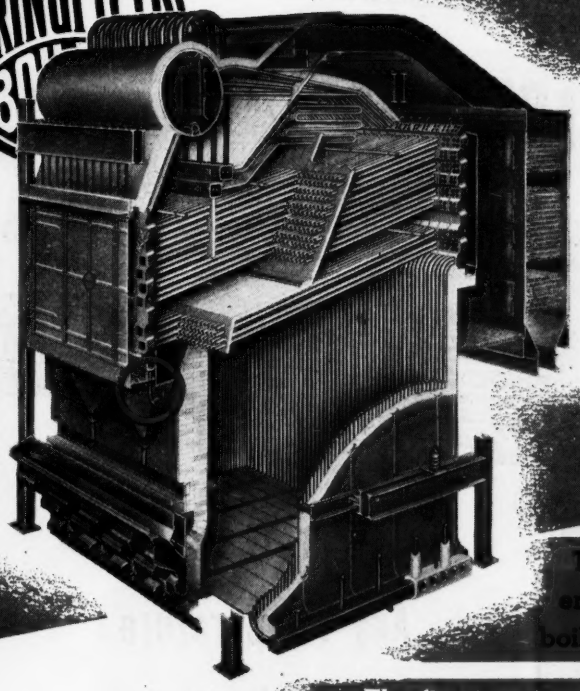
FLO-CONTROL VALVE FOR CONTINUOUS BLOW-OFF SYSTEM

TOP VIEW SEDIMENTATION TANKS SHOWING DRIVE FOR STIRRING MECHANISM

COCHRANE CORPORATION **3123 N. 17th ST., PHILADELPHIA 32, PA.**

COCHRANE

SOFTENERS • DEAERATING SOFTENERS • DEAERATORS • METERS • STEAM SPECIALTIES



SPRINGFIELD *Developments*

That Led to the Present Original and Modern Springfield Water-Tube Boiler

The first continuous "high rating" operation was produced on Springfield boilers!

The first commercially successful water wall installation in America was made by Springfield!

The close spaced water wall was developed and first installed by Springfield!

The center wall divided furnace was developed and first successfully used by Springfield!

The staggered group tube arrangement was developed and its use extended by Springfield!

The production of better boiler headers by use of cast steel has been pioneered and developed by Springfield!

The first and only cast steel mud drum was developed by Springfield!

The modern application of cast electric steel headers for marine boilers has been developed exclusively by Springfield!

It stands to reason that it is wise buying to investigate the products of a company that has so consistently pioneered sound developments which have brought big advantages to boiler users.

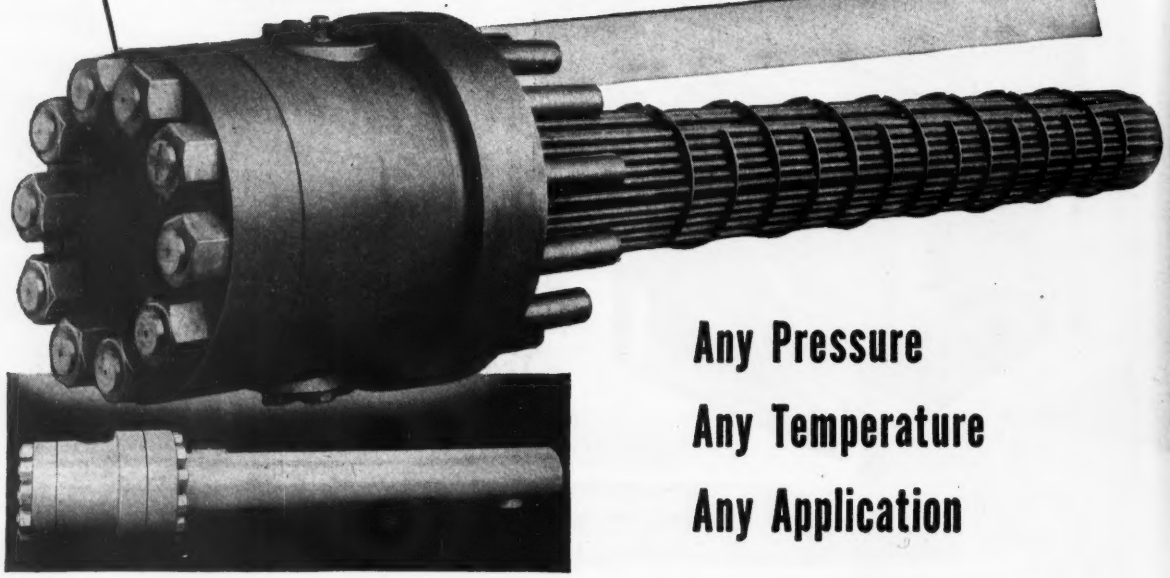
We have no hesitation in saying "Compare a Springfield" point for point with any boiler. Write today.

SPRINGFIELD BOILER COMPANY
1951 E. Capitol Avenue
Springfield, Illinois

SPRINGFIELD BOILERS

SPRINGFIELD
STEAM GENERATING UNITS
ANY SIZE—ANY FUEL—ANY PRESSURE

SOUNDLY BASED DESIGN



Any Pressure
Any Temperature
Any Application

LUMMUS POWER PLANT EQUIPMENT

SURFACE CONDENSERS
•
BAROMETRIC CONDENSERS
•
STEAM JET AIR EJECTORS
•
BLEEDER HEATERS
•
BOILER BLOWDOWN HEAT EXCHANGERS
•
EVAPORATORS
•
FUEL OIL HEATERS
•
LUBRICATING OIL COOLERS

Another high pressure heat exchanger designed and fabricated by Lummus for a specific installation is illustrated above. This gas-to-gas unit is now giving trouble-free operation while maintaining full performance requirements at maximum loads.

Designed for a major salt manufacturing company, the basic problem called for a 2,500 psi working pressure on both the shell and tube sides. The soundly engineered Lummus solution was a forged steel shell, channel and cover construction with the tube sheet integral with the channel. The unit was tested at 5,000 psi before installation.

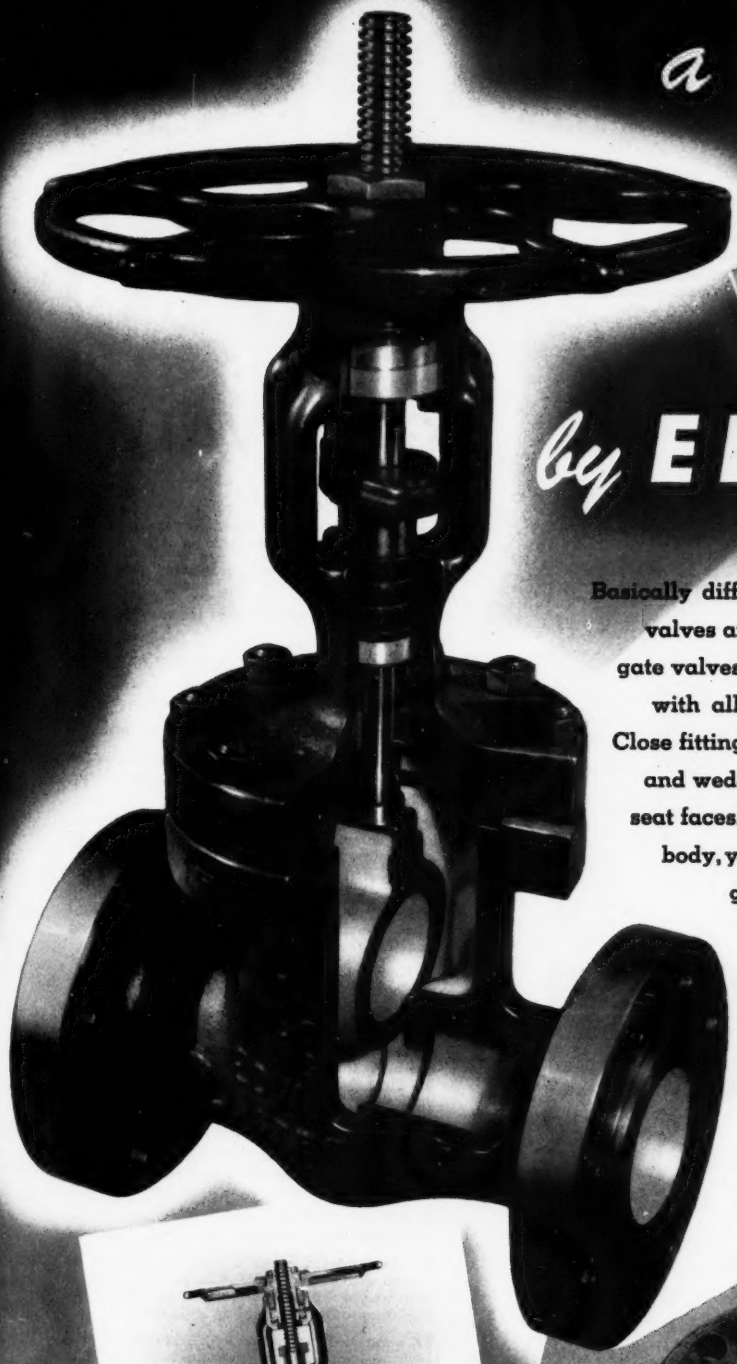
Lummus engineering service is always available for the study of specific heat exchanger problems and the modernization of power plants to meet post war requirements. For further information write to:

THE LUMMUS COMPANY · 420 LEXINGTON AVE., NEW YORK 17, N.Y.

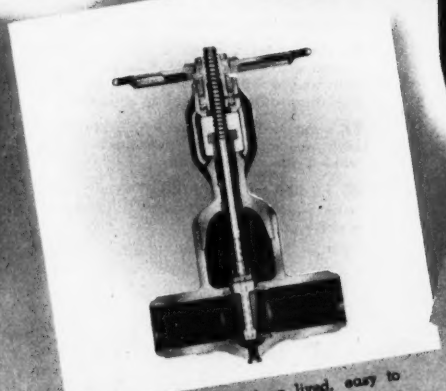
LUMMUS

HEAT EXCHANGERS

a new, better GATE VALVE *by* EDWARD



Basically different in design, Edward cast steel gate valves are tight, *stay* tighter than you thought gate valves could.... Here at last is a gate valve with all working parts in perfect alignment. Close fitting guide ribs, located *after* seat rings and wedge are in place, prevent wedge drag on seat faces. Hard faced seats are integral with body, yet replaceable. And with the new Edward gate valve testing method, *both* seating faces must be tight simultaneously.... The new Edward gate valves are built in 2½ to 12 in. sizes for service from 150 to 3600 lb. In many sizes and pressure classes they are available for immediate shipment.



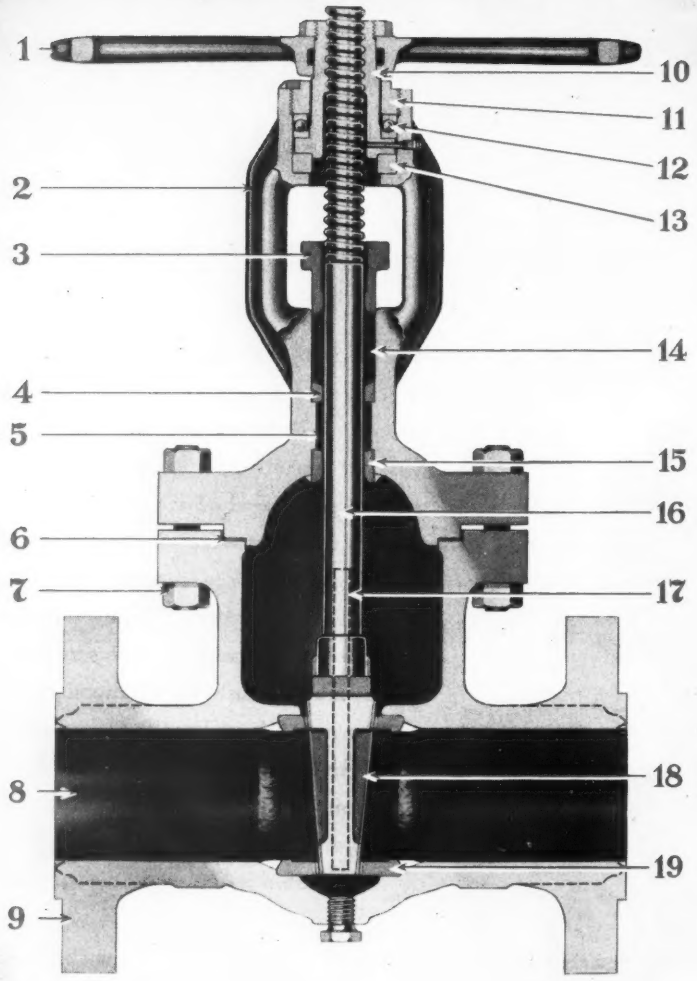
Simple, functional, long lived, easy to maintain. Edward gate valves have no unnecessary parts, no pockets or recesses within the body to encourage start of excessive corrosion.

In contrast with traditional gate valve design, guide ribs in Edward gate valves are accurately located with respect to seat faces and wedge, then welded integrally to body with continuous weld fillets. Thus clearances are cut to minimum and wedge can travel practically to closed position before touching seating faces, greatly reducing wear.

TURN PAGE FOR DETAILED DESCRIPTION OF CONSTRUCTION FEATURES

DESIGN FEATURES

of the new EDWARD Cast Steel GATE VALVE



1 Large diameter handwheel. Edward patented Impactor handwheel available on order.

2 Cast steel one-piece outside screw and yoke type bonnet.

3 Steel gland, through-bolted for easy packing adjustment.

4 Junk ring, EValized for resistance to galling and wear.

5 Large cooling chamber protects packing.

6 Edward male-female body-bonnet joint.

7 Alloy steel studs, threaded entire length for evenly stressed fit. Nuts tightened with torque wrenches for uniform gasket loading.

8 Cast steel body with equalized metal sections to prevent stress concentrations. Tapped hole in body below wedge makes clean-out easy.

9 ASA flanged ends or welding ends.

10 Alloy yoke bushing, EValized to reduce wear. Alemite fitting for lubrication of bushing and stem threads.

11 Hardened EValloy stainless steel yoke bushing locknut with flats for easy removal.

12 Ball thrust bearings in sizes where torque to operate valve exceeds that comfortably exerted by one man. Two ball bearings in large sizes, one in medium sizes, EValized non-galling bearing plates in small sizes.

13 EValized steel lower bearing plate reduces friction and eliminates galling.

14 Specially processed EValpak packing. Top and bottom rings jacketed and reinforced with Monel wire.

15 EValloy bonnet bushing for pressure-tight corrosion-proof backseat with stem shoulder.

16 Heat treated EValloy stem of uniform diameter with heavy tee-head making full contact with wedge slot for uniform pull on wedge. Self adjusting radial backseating shoulder.

17 Long steel wedge guides accurately located with respect to seat rings and wedge, then welded integral with body.

18 EValloy or Stellite hard faced wedge with wide contact areas ground to mirror-like flat surfaces.

19 Rolled or forged steel Stellite hard faced seat rings, welded integral with body. Replaceable.

NEW GATE VALVE CATALOG READY!

The Edward Valve & Mfg. Co., Inc.
East Chicago, Indiana

Please send your new Catalog No. 12-E illustrating and describing Edward cast steel gate valves.

Name_____

Company_____

Position_____

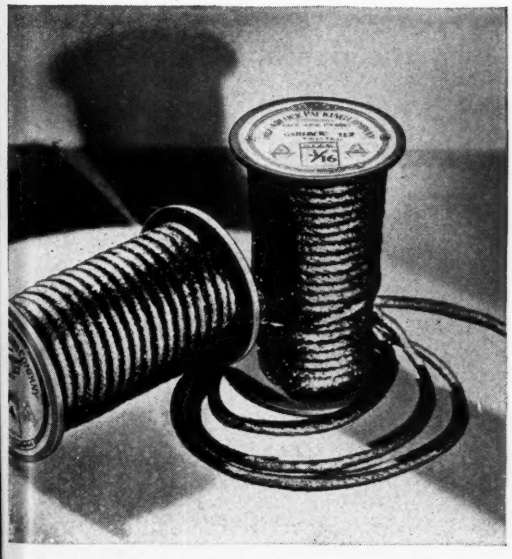
Street_____

City_____ Zone_____ State_____

THE EDWARD VALVE & MFG. CO., Inc.

EAST CHICAGO, INDIANA

Edward Cast and Forged Steel Valves: Globe and Angle Stop . . . Non-Return . . . Check . . . Blow-Off . . . Intex (Integral Seat) . . . Feedline Stop-Check . . . Relief . . . Hydraulic . . . Gage . . . Strainers . . . Special Designs for all Pressures and Temperatures for Boiler Room, Petroleum, Marine, Industrial and Technological Services.



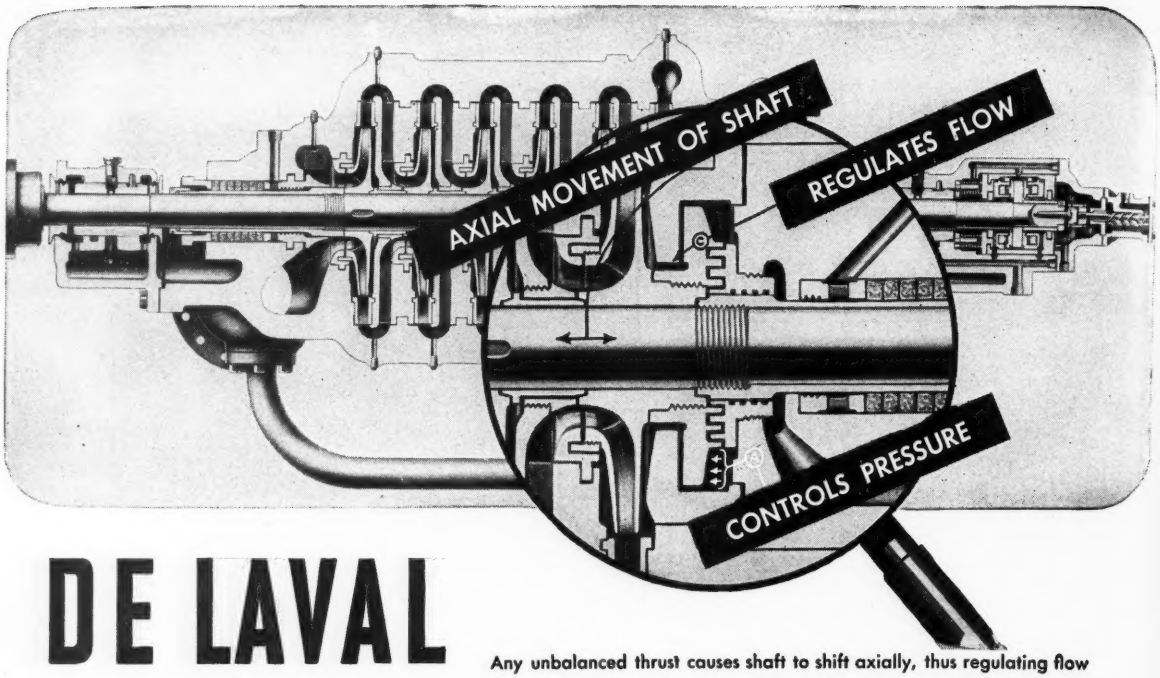
GARLOCK 117 globe and angle valve stem packing is equally effective against high pressure steam, hot or cold water, or oil. Furnished either braided or twisted in all sizes from 1/16" to 3/4".

"They Sure Hold Up!"

GARLOCK Packings may not last several generations—but they do give much longer service than ordinary packings, because they are produced in our own plant and are *quality-controlled* from raw material to finished product.

The Garlock Packing Company, Palmyra, N.Y.
In Canada: The Garlock Packing Company of Canada Ltd. Montreal, Que.

Garlock



DE LAVAL

BALANCING ARRANGEMENT *Automatically* BALANCES ALL THRUST

Any unbalanced thrust causes shaft to shift axially, thus regulating flow through clearance C, thereby controlling pressure against balancing disc A and thus automatically returning the pump to a state of perfect balance. Note that this hydraulic device leaves no unbalanced thrust to be taken up by bearings or other metallic contacts subject to wear.

ELIMINATES SOURCE OF TROUBLE IN HIGH-PRESSURE BOILER FEED PUMPS

The erosive action of high-temperature feed water in a high-pressure boiler-feed pump does not interfere with the operation of the De Laval automatic hydraulic balancing arrangement, since the automatic action of this device is in no way affected by normal wear, as can be seen from the illustration. Its universally trouble-free performance has been demonstrated over a period of 30 years in hundreds of installations, handling feed water up to 350° F. and discharging against pressures up to 1600 psi.

3630

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS and COMPRESSORS • IMO OIL PUMPS

DE LAVAL

STEAM TURBINE COMPANY · TRENTON 2, NEW JERSEY

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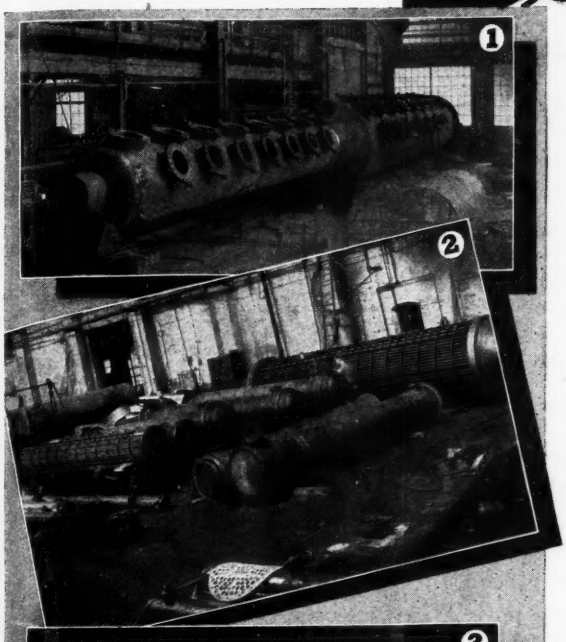
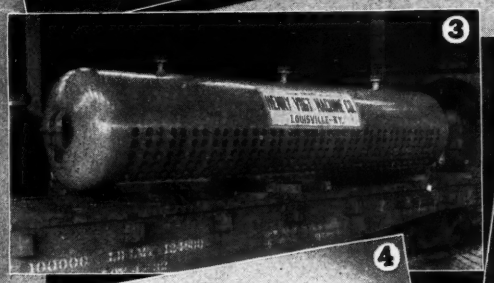
A.P.I.—A.S.M.E. and A.S.M.E. CODES • CARBON STEEL AND SPECIAL STEEL

WELDED PRODUCTS by Vogt





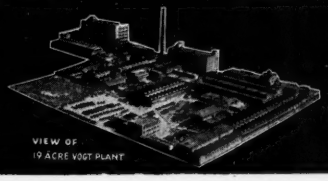
1 - 4′—0″ dia. x 7′—6″ dia. x 82′—5″ high Stabilizer Tower for a Texas Refinery. Fabricated to A.P.I.-A.S.M.E. Code, stress relieved and X-rayed. 250# working pressure.

2 - Heat Exchangers, for an Eastern Refinery, on the testing floor. Units have fusion welded Monel Metal shells and were built to customer's specifications.

3 - 48″ dia. x 22′—6″ long mud drum for a Vogt Water Tube Boiler designed to operate at 450# S.W.P. Fusion welded to A.S.M.E. Boiler Code.

4 - Battery of Absorption Columns in a Western Refinery. Units are 33″ dia. x 41′—0″ high and were stress relieved after welding.

5 - 400 KV Industrial X-ray unit in our plate welding department. Exographs of welded seams can be quickly made because of the special motor operated rolls and traveling carriages which are adjustable to vessels of any size.



VIEW OF 19 ACRE VOGT PLANT

HENRY VOGT MACHINE CO.
Incorporated
LOUISVILLE, KENTUCKY
BRANCH OFFICES: NEW YORK · PHILADELPHIA · CLEVELAND · CHICAGO · DALLAS

What power plant operators sa

No.1 Six years continuous boiler service

"The two 400-pound pressure boilers at our Camas, Washington plant (a large paper mill) have been on the line for six years, except for the annual holiday shutdowns of 4th of July, Labor Day and Christmas.

"Our Chief Steam Engineer reports that on this last 4th of July shutdown he again examined the boilers and found them in excellent condition, and that he considers that this good operation may, to a very large extent, be attributed to the success of the Hall System of boiler water conditioning."

No.2 Boilers stay in first class condition

"During the summer of 1941 the plant (a large tire and rubber company in Canada) installed a new boiler to operate at higher ratings than the old boilers, and desired to keep this new boiler in continuous operation except for scheduled outages, such as semi-annual inspections, etc." Three months after institution of Hall service the following report was received from the plant engineer: "We now have No. 7 boiler removed from the line after approximately three months' run, and it will be out of service for approximately a week.

"We have the manholes of the drums open as well as several hand holes in the side wall headers removed, and we feel that from observation the boiler is in first-class condition."

No.3 Boiler Tubes Clean as a Whistle

"Boilers (large iron works) cleaned, turbined and inspected on August 1. The boiler was found to be clear of scale and was in first-class condition. The turbining was done mainly through a set rule rather than through need of it. Client said it was like running the turbine through new tubes."

ssay about Hall Service:

These enthusiastic testimonials from Hall clients are an indication that Hall System of Boiler Water Conditioning is really doing a worthwhile job. Power Plants are staying in service continuously when they are needed most. What's more, some of the manpower and steel formerly needed for maintenance work can be used for other purposes.

The Hall System of "Preventive Care" keeps boilers healthy. A Hall Field Engineer is prepared to help you correct any boiler trouble that may develop. Supporting him are the most complete boiler service laboratories in existence for this need. However, his main job is to help you apply *preventive* aid.

In your own experience you can probably recall dozens of cases of boiler outages which wouldn't have occurred had you done sooner the things you learned too late. There was never a time when a service like this could mean as much to you as it does today. May we tell you about it?

ALL LABORATORIES · HAGAN BUILDING · PITTSBURGH 30, PA.

HAGAN
HALL
BUROMIN
CALGON

HALL SYSTEM *of Boiler Water Conditioning*

Hall Service in a Nutshell

At your immediate disposal are placed the technical knowledge and facilities of the pioneering leaders in scientific boiler water conditioning. In addition, with your full cooperation, Hall Service:

1. **Minimizes boiler outages caused by water.**
2. **Helps maintain highest efficiency.**
3. **Establishes non-embrittling water.**
4. **Minimizes carryover.**
5. **Prevents corrosion in boilers and associated equipment.**
6. **Prevents deposition in water lines and cooling systems.**

Because the yarn is Interlocked and braided square

THIS ROD PACKING CAN'T UNRAVEL OR COME APART!

THE BRAIDING of the asbestos yarn in Johns-Manville Interlocked Rod Packing is done in a unique and exclusive way. Instead of braiding jacket over jacket, which unravels with wear, the long-fiber asbestos yarn is braided right into the body of the packing and securely interlocked to form a solid, integral structure. Naturally, this means longer packing life and fewer repacking jobs for you!

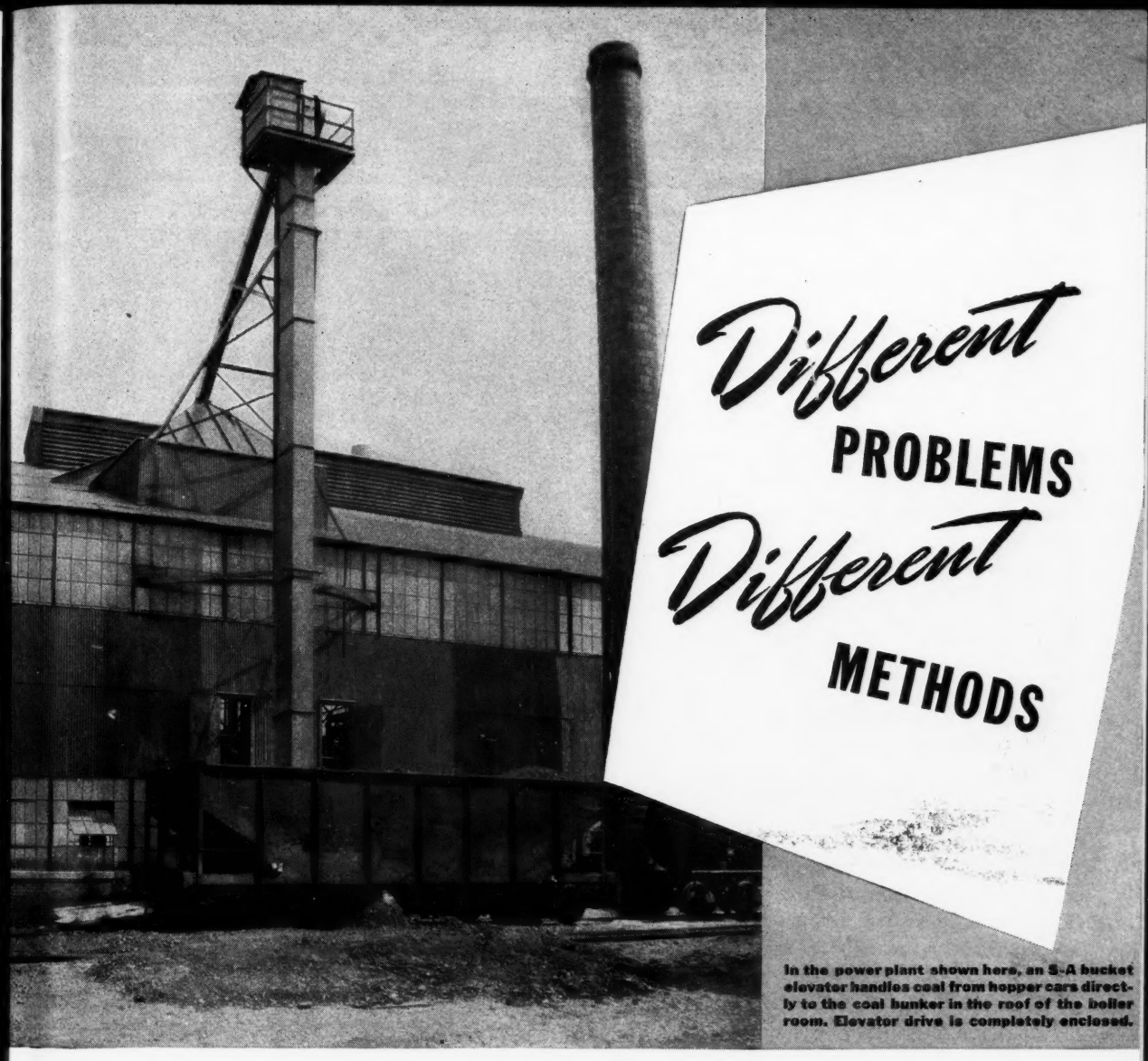
Furthermore, J-M Interlocked Rod Packing is braided square . . . not braided round and pressed square . . . resulting in a more flexible and resilient packing. This square-section structure presents a better contacting area and provides a tight seal with minimum gland pressure.

J-M Interlocked is now available in a variety of compositions to meet a wide range of operating conditions—such as Nos. 255 and 257 for use against saturated or superheated steam, hot or cold, fresh or salt water, oils and weak caustics or acids, No. 253 for paper stock pumps, No. 259 for gasoline service, and No. 270 for hot oil packing. For more details, write for catalog PK-12A. Johns-Manville, 22 East 40th Street, New York 16, N. Y.

JM PRODUCTS

Johns-Manville PACKINGS & GASKETS

THERE'S A J-M DISTRIBUTOR NEAR YOU



In the power plant shown here, an S-A bucket elevator handles coal from hopper cars directly to the coal bunker in the roof of the boiler room. Elevator drive is completely enclosed.

In This Case **S-A** *Bucket Elevator Is Key to Efficient Coal Handling . . .*

On the choice of the right type of handling equipment rests the success of your coal handling system for a long time to come. But unless each type is thoroughly investigated, there's a chance that the resulting installation will fall short of giving you maximum possible efficiency.

A Stephens-Adamson review of your problems is sure to cover the field. Because this company manufactures all basic conveyor and elevator types, its recommendations can be depended on to be free of any bias. The system which proves best suited to your special requirements may be a bucket elevator, like the one shown here. But you'll know that belt and enclosed types also receive full consideration.

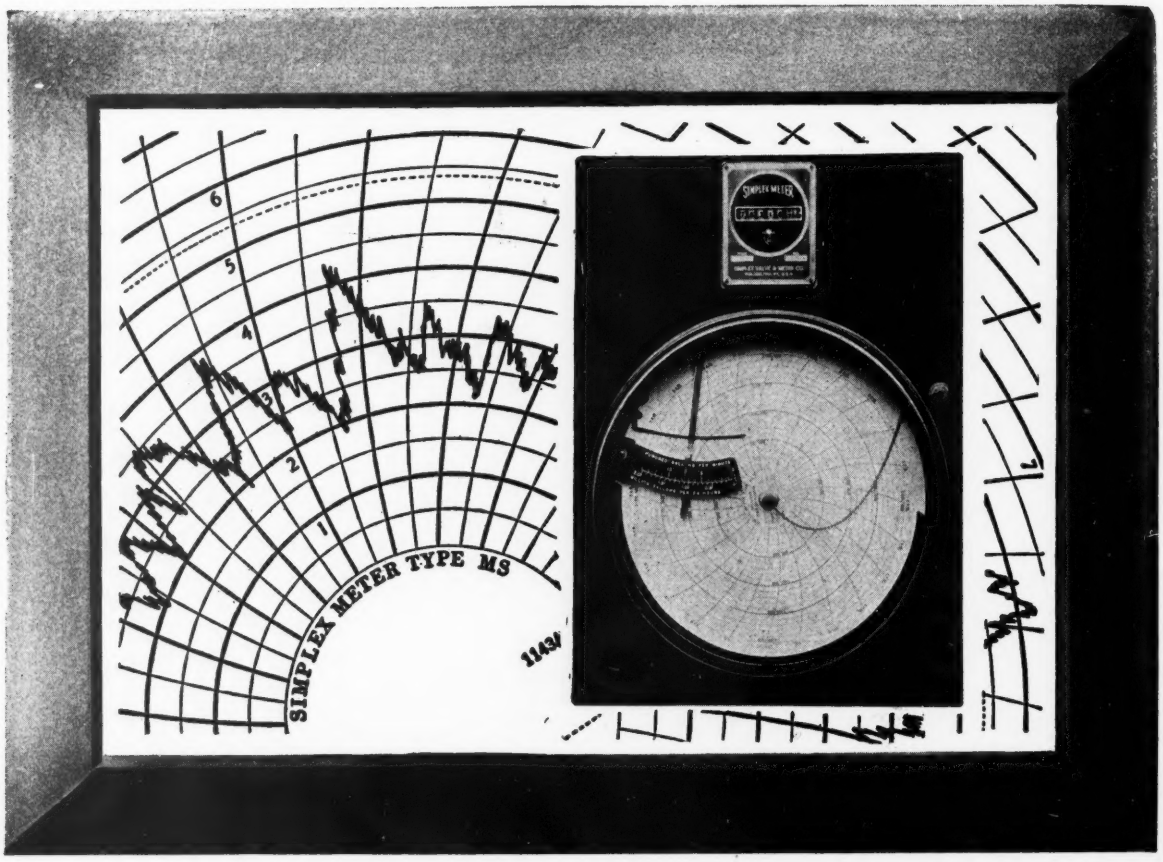
You'll know, too, that whatever type is recommended, it will incorporate all that is best of Stephens-Adamson's 43 years experience in solving material handling problems to the users full satisfaction.

STEPHEN S-A ADAMSON MFG. CO.

515 RIDGEWAY AVENUE, AURORA, ILLINOIS — LOS ANGELES, CALIF. ★ BELLEVILLE, ONT.

Designers and Manufacturers of All Types of

BULK MATERIAL HANDLING EQUIPMENT



Portrait of A STEAM SLEUTH

What are the facts about steam that can save you dollars — conserve your manpower — increase operating efficiency?

The surest FACT FINDER is a Simplex MS Flow Meter on your steam lines, because it puts the finger of suspicion on defective equipment, relative quality of fuel, efficiency of the operating staff — and gives recorded flow rate data — the basis for effective control.

What are the reasons for the high accuracy of the MS Meter which makes it ideal for power plant use?

(1) The bell shaped float moves in direct proportion to the rate of flow.

(2) The direct reading, evenly spaced chart assures the same high accuracy and visibility of readings over the entire flow range.

(3) 7 digit totalizer simplifies integrating of flow and adds weeks of continually increasing daily computations before counter returns to zero. The seventh digit is a means of closely checking the flow.

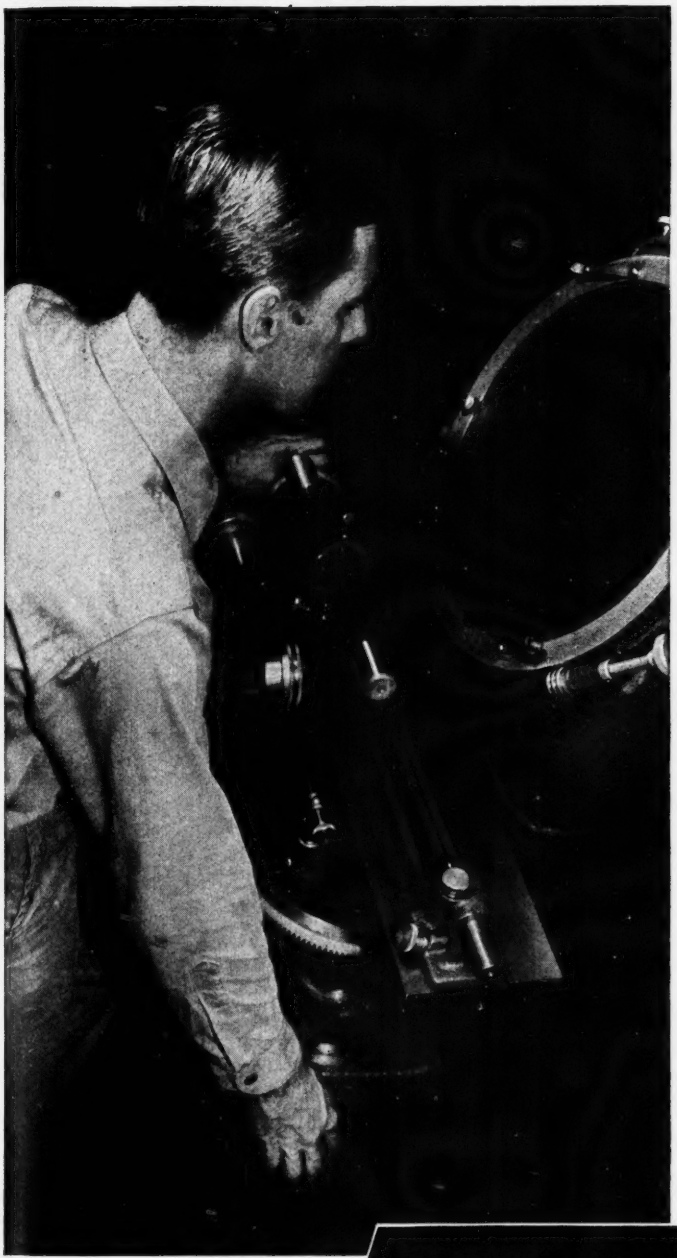
(4) Moisture-proof chart paper eliminates errors resulting from stretching and shrinking.

(5) The MS meter integrates, records, totalizes — in any desired combination. Remote reading also is available.

Put the facts about your steam flow to work for you. Write today for information on the Simplex MS Flow Rate Meter.

SIMPLEX VALVE & METER COMPANY
6783 UPLAND STREET, PHILADELPHIA, PENNA.

Test after Test Leads to Year after Year of Dependability



One of many tests of Busch-Sulzer parts. Magnified 62½ times, the image of screw threads is compared with a standard form to prevent errors not visible to the naked eye.

Every part of every Busch-Sulzer Diesel engine is rigidly inspected and tested for strict adherence to specifications before assembly. Then the assembled engine undergoes an operating test for performance standards. Finally, before shipment, the dismantled engine's working parts are given another painstaking inspection.

This testing is but one of the factors that contribute to Busch-Sulzer Diesel engines' reputation for dependability and long life. Other factors are the skill that should be expected of America's first builder of Diesels—plus simplicity of design that results in fewer moving parts, better lubrication and less wear.

Our facilities and trained personnel have been greatly expanded in wartime. When conditions permit, we will go right to work on postwar orders without reconversion delays. Why not acquaint us now with your requirements? We build both marine and stationary engines, both 2-cycle and 4-cycle, with a variety of speeds. An inquiry on your letterhead will receive prompt attention.

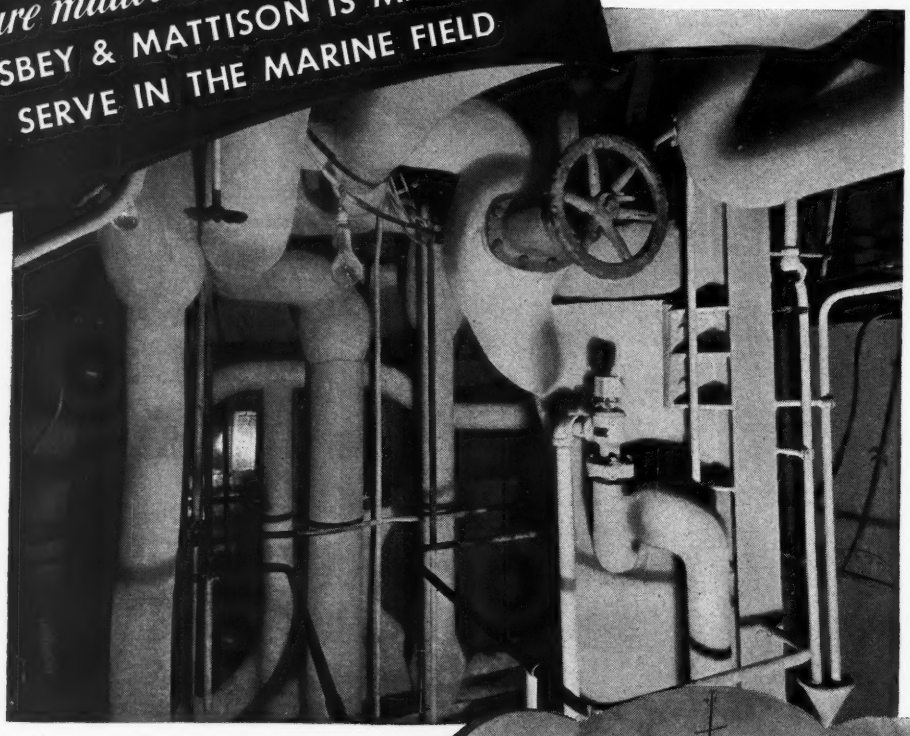
BUSCH-SULZER BROS.–DIESEL ENGINE COMPANY
SAINT LOUIS

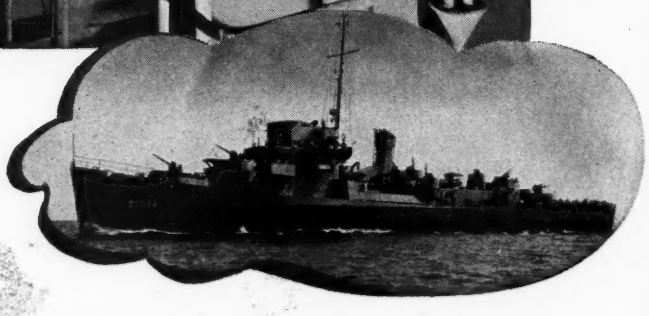
BUSCH-SULZER
ST. LOUIS

America's Oldest Builder of
DIESEL ENGINES

Nature made Asbestos HERE IS HOW KEASBEY & MATTISON IS MAKING IT SERVE IN THE MARINE FIELD

USS "Bunch" a Destroyer-Escort Vessel, built by the famous "Defoe Roll-over Process" by the Defoe Shipbuilding Company, Bay City, Michigan. Keasbey & Mattison heat insulations installed by the Armstrong Cork Company.





K&M High Temperature Insulations

Save Steam and Power!

Keasbey & Mattison Asbestos products have seen extensive service in the Marine Field during the war. The above example is typical. The intricate network of steam lines, which are an essential part of the DE'S power plant, are completely insulated with K&M "Featherweight" 85% Magnesia and K&M Hy-Temp Covering.

K&M "Featherweight" 85% Magnesia Insulation is designed for temperatures up to 600°F. — Hy-Temp for temperatures to 1900°F. The proven quality and dependability that these K&M Insulations have shown at sea has also been apparent in every industrial use to which they have been put. In hundreds of plants throughout the country, these insulations are daily saving tremendous quantities of heat, fuel and power.

KEASBEY & MATTISON

COMPANY • AMBLER • PENNSYLVANIA

Invaluable to Engineers . . .

• A Series of Technical Papers Based on Original Gasket Research

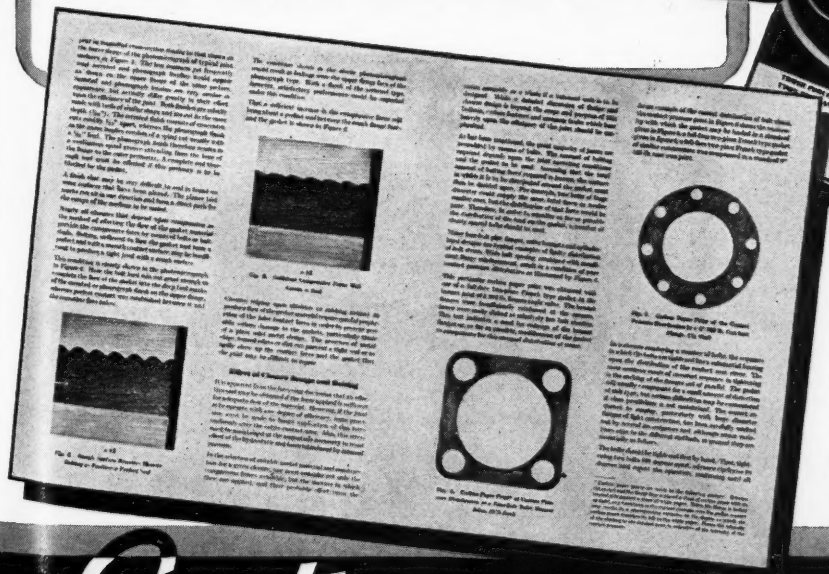
To provide highest joint efficiency — especially mandatory for confining dangerous or corrosive fluids or for withstanding high temperatures and pressures — Goetze, at once, must be expert in metallurgy, mechanical engineering, steam engineering and chemistry.

The unique laboratory at the Goetze plant, continuously engaged in research in the effects of metallic structure upon gasket performance, the determination of true gasket yield stress value and gasket factor, proper flange and bolt specifications, etc., has amassed a wealth of original data of interest to engineers and designers of pressure equipment.

These data are being published in a series of technical bulletins — a part of Goetze service to Industry. If you wish to receive these bulletins regularly, write on your letterhead, mentioning your position.

Also available — a handy up-to-the-minute gasket chart showing the cross sections of 36 most popular gasket types, their purposes and the characteristics which fit them for the specific services intended — is yours for the asking.

GOETZE GASKET & PACKING CO., Inc.
17 ALLEN AVENUE, NEW BRUNSWICK, NEW JERSEY

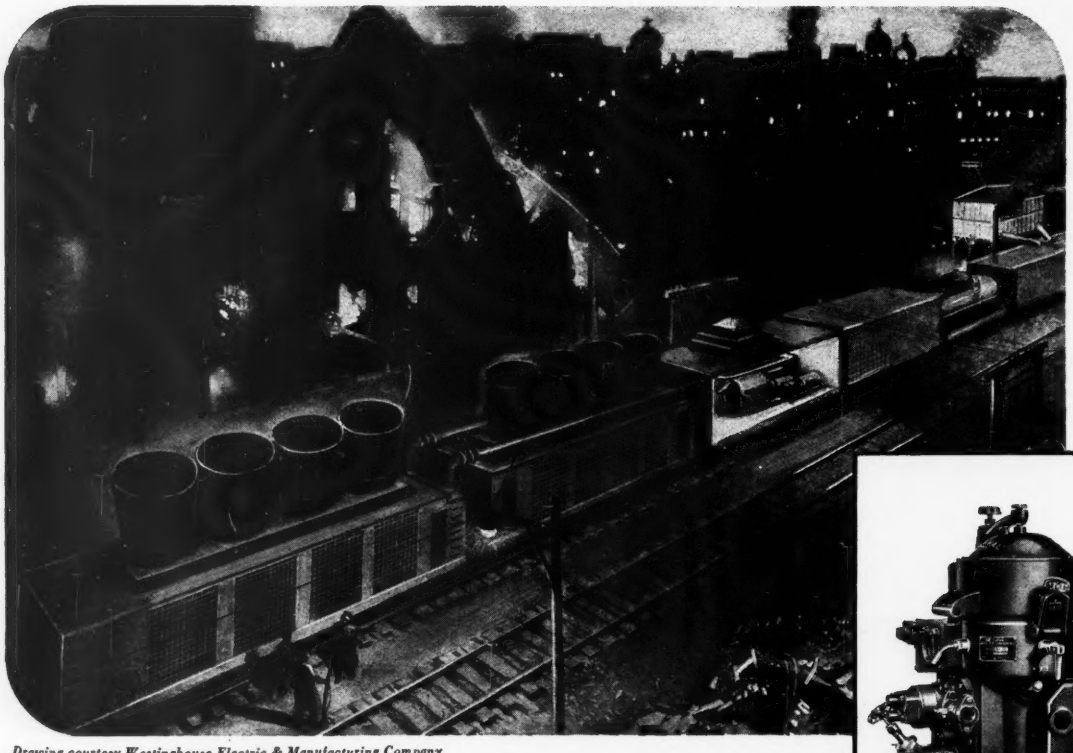


LOWELL THOMAS Speaks on New Gasket Film

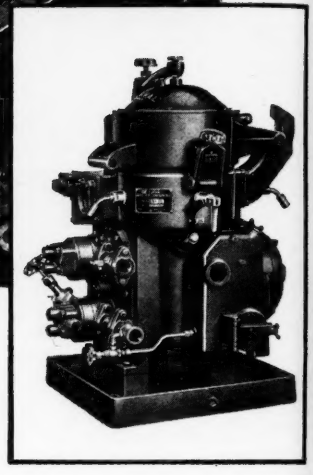
Now available to employee groups, technical societies, engineering schools and other organizations throughout the country, this new 35-minute Kodachrome film, "Only a Gasket," tells why these are the "Biggest little things" in modern Industry. Write for full information.

Goetze for GASKETS

"America's Oldest and Largest Industrial Gasket Manufacturer"



Drawing courtesy Westinghouse Electric & Manufacturing Company



DE LAVAL Oil Purifiers

PROTECT TURBINES on POWER TRAIN

MOVING swiftly into a village ravaged by war, this Westinghouse Power Train quickly provides all the equipment of a full size power plant of 5000 kilowatts. It can produce its power output in temperatures as low as –40° F., and usually must operate under conditions demanding a minimum of attendance or supervision.

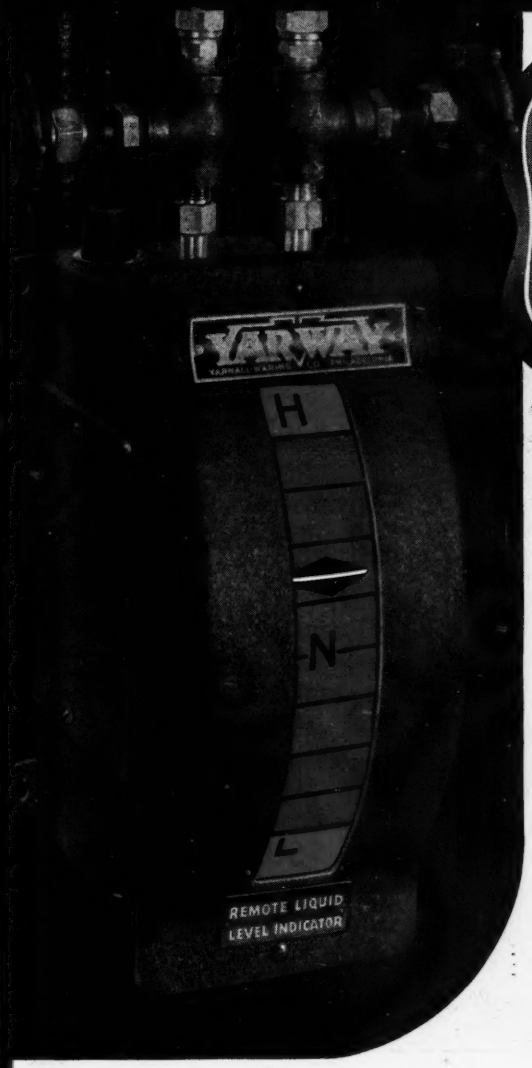
It is quite natural, therefore, that the oil purification equipment aboard should consist of a De Laval centrifugal machine. De Laval Oil Purifiers stand up under even the most rugged conditions, performing without failure the service for which they were designed — the removal of harmful impurities and water from lubricating oil. The constantly purified oil is enabled to protect the bearings indefinitely at full efficiency.

There is a range of types and sizes of De Laval Oil Purifiers to assure the proper machine for every power plant. Write for detailed information, sent without obligation.

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 19
THE DE LAVAL COMPANY, Limited
MONTREAL PETERBOROUGH WINNIPEG VANCOUVER

DE LAVAL OIL PURIFIERS

FOR MORE DEPENDABLE POWER PRODUCTION



Now . . .

MORE ACCURATE READINGS OF BOILER WATER LEVELS

"Positive as the Law of Gravity"

The Yarway Remote Liquid Level Indicator offers you this on a brightly-lighted scale right on your instrument panel or at any other convenient location. No more guessing at hard-to-see gages. No more risk of serious damage to equipment due to inaccurate water level readings. *Now double-check your overhead gage readings with this Yarway Eye-level Instrument.*

Its accuracy and dependability are "positive as the law of gravity" for this instrument literally "weighs" the difference between a constant column of water and the varying level in boiler drum and indicates the difference by pointer movement over a calibrated scale.

Indications are instant. The luminous pointer follows the water level constantly—is always visible, even in complete darkness. The indicating mechanism is never under pressure—is frictionless—is perfectly balanced on jewelled bearings. *There are no stuffing boxes.* Indicating and actuating mechanisms are completely separated, but operate simultaneously through a powerful, permanent magnet transmission.

Accelerated endurance tests in the Yarway Steam Laboratory have duplicated 50 years of normal boiler service without need for repair, replacement of a single part or recalibration.

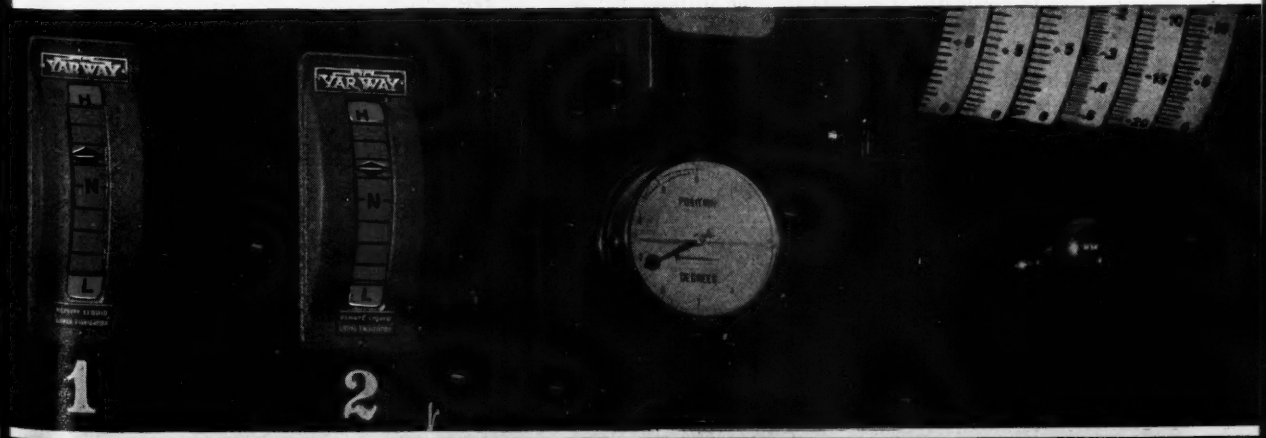
Easily installed on new or existing boilers or other equipment requiring liquid level indication.

Suitable for pressures up to 1500 lb. Hundreds have been purchased and repeat orders indicate enthusiastic user satisfaction. Write for Bulletin WG-1820.

YARNALL-WARING CO. 114 Mermaid Ave., Phila. 18, Pa.

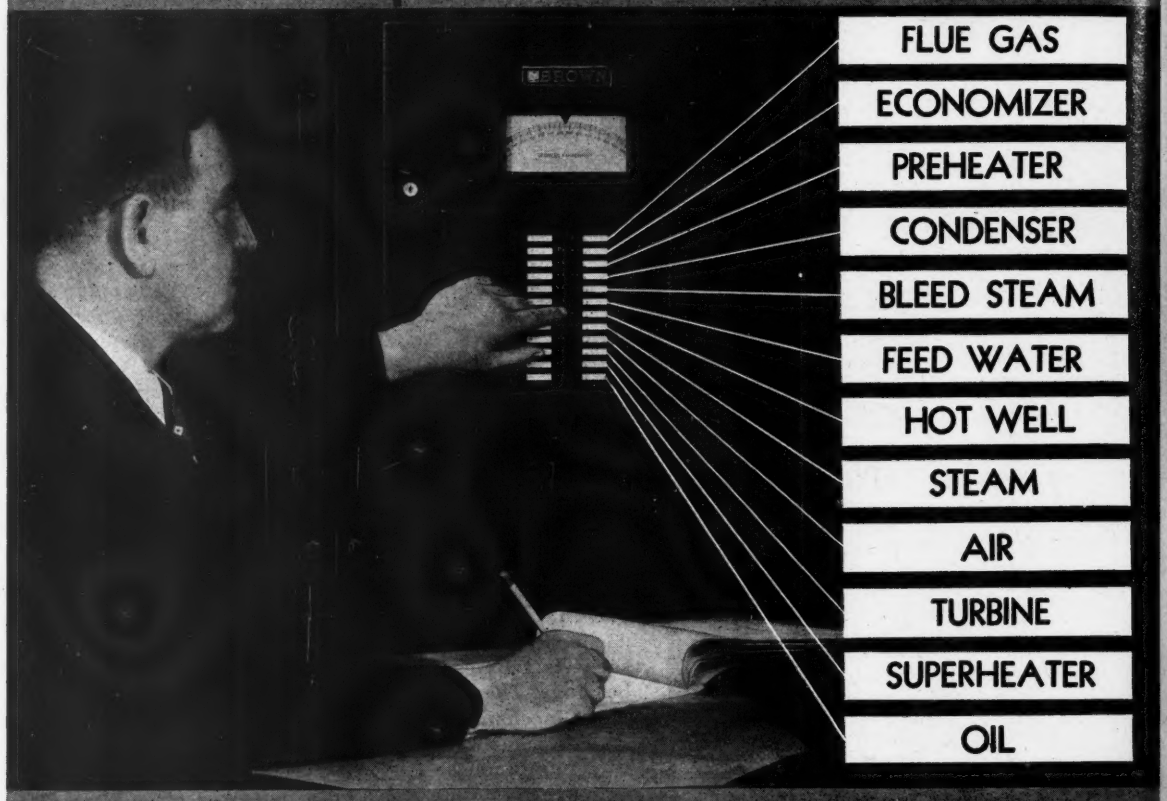
Above: The Yarway Remote Liquid Level Indicator for mounting on wall or building column.

Below: Two Yarway Liquid Level Indicators mounted on instrument panel of prominent high pressure New Jersey Utility.



YARWAY REMOTE LIQUID LEVEL INDICATOR

Check these Temperatures within a Few Seconds



ELIMINATES MANUAL BALANCING

The self-balancing Centralized Reading Indicator pictured above is as modern as jet propulsion.

The operator merely touches the desired switch. The instrument does the rest, leaving his hands free to log readings.

Time required between readings is limited *ONLY* by human ability to pick off a reading. Compare this time to that required to read an outmoded *manual* balance indicator, designed when shaving mugs were on every barber shop shelf.

The Brown Centralized Reading Indicator is unique for other reasons too.

The electronic "Continuous Balance" principle delivers sensitivity previously unheard of. Fancy being able to read one part in twenty-four hundred!

The ElectroniK is totally unaffected by vibration—mount it on a pulverizer frame if it suits your purpose.

The ElectroniK utilizes circular instead of reciprocating motion. Components move only when the scale is changing position.

Specify the Brown Precision Indicator for that post-war boiler.

Specify it, too, for your present station. Utilizing the same wiring and thermocouples, it readily replaces old-fashioned instrumentation.

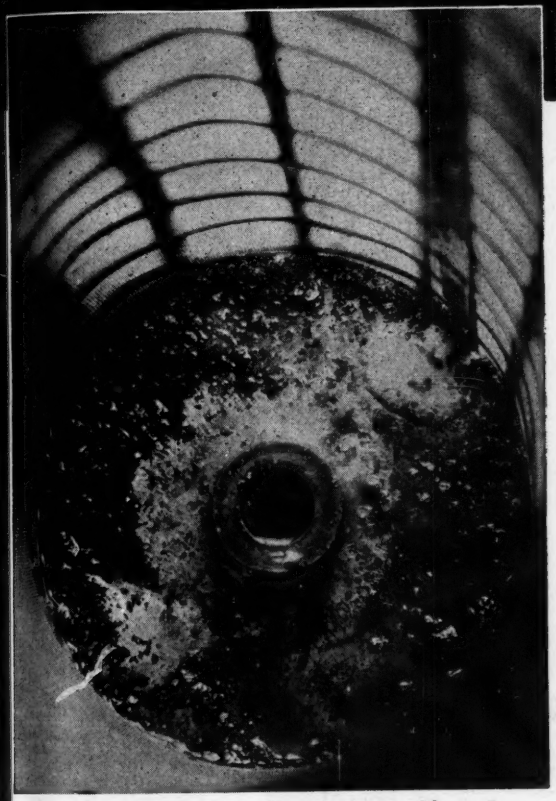
Write for Bulletin 15-4, The Brown Instrument Company, *a division of Minneapolis-Honeywell Regulator Company,* 4491 Wayne Avenue, Philadelphia 44, Pa. Branches in all principal cities. Canadian factory: 119 Peter Street, Toronto, Canada; Wadsworth Road, Perivale, Middlesex, England; Nybrokajen 7, Stockholm, Sweden.

BROWN *Electronik* POTENTIOMETERS

NOW!

Your Turbine Lubricating System can be cleaned with less trouble and greater efficiency . . .

BY USING THE NEW SHELL CLEANING PROCEDURE



Oil's-eye-view of duplex strainer with rust, scale and metal chips removed in five minutes of circulation. New turbine and new oil, but system improperly cleaned.

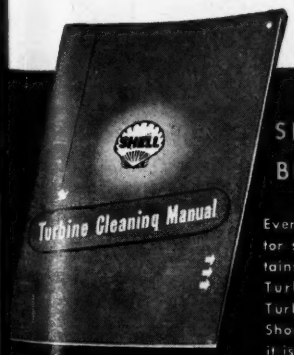
THE Shell Turbine Cleaning Procedure is the result of experience gained in cleaning many kinds of stationary and marine turbine lubricating oil systems, under all types of operating conditions.

That there is a need for the thorough cleaning of dirty oil systems is beyond question. And the cleaning of new equipment is equally important. For materials such as loose mill scale, metal chips, core sand, gasket compound, slushing compound, run-in oil and any rust that may have formed during the erection of the turbine, can cause trouble if left in the system.

Just what *is* the best method of cleaning? It has been found that manual cleaning is not practical. Flushing the system with turbine oil is not enough because turbine oil has little solvent power for sludge, and material which has precipitated from it will not readily be dissolved by a similar oil.

By using the new Shell Turbo Cleaner and the recommended Shell Procedure even the most severe cases of contamination, rusting and sludging have been cleared up.

For the complete details, get in touch with the Shell Oil Company, Inc., 50 W. 50th St., New York 20, N. Y., or 100 Bush St., San Francisco 6, Calif.



SEND FOR THIS BOOKLET NOW!

Every turbine owner and operator should have a copy. It contains full details on the new Shell Turbo Cleaner and the Shell Turbine Cleaning Procedure. Shows you how simple and easy it is to keep your turbines clean operating at peak efficiency.

SHELL

SHELL TURBO OIL

This is our "imagineering" department — development stoker engineering men concentrating on improvements and new developments in the Taylor Stoker.

General engineering offices of the American Engineering Company. Many of these men have a record of 10, 15, 20 or more years of stoker engineering experience under their hats.

ENGINEERING EXPERIENCE HAVE TO DO WITH

STOKER PERFORMANCE?

IT TAKES a real amount of engineering ability to sit down and design a stoker. But to design a reliable stoker from which you can derive the maximum possible operating efficiency at the lowest cost requires another ingredient—STOKER ENGINEERING EXPERIENCE.

Stoker engineering experience isn't something one can read up on in a book. It is the sum total of years of perfecting and rejecting principles, of designing, testing and redesigning, of developing ideas and observing them under actual operating conditions. It contributes "know-how", the factor of experience which is beyond the direct interpretation of drawings and which results from having designed and installed so many multiple retort stokers in this and other countries.

Stoker engineering experience investigates every single part of a stoker trying to make it work better, last longer, or make it easier or cheaper to replace.

These engineering advantages, the culmination of 40 years of *stoker* engineering experience are an integral part of Taylor Stoker manufacture—another plus to add to many Taylor mechanical features which assure you efficient, reliable, low cost generation of steam.

JUDGE THE SELECTION OF FUEL FIRING EQUIPMENT BY THESE TWELVE POINTS

1. RELIABILITY—the ability to operate with minimum outage and minimum standby equipment.

2. CAPACITY—the ability to provide adequate prime capacity ratings, with sufficient reserve capacity for emergencies.

3. MAINTENANCE—the ability to operate continuously with minimum repair costs.

4. FLEXIBILITY—the ability to follow the steam demand upward or downward . . . quickly and without sacrificing efficiency.

5. EFFICIENCY—the proved dollar efficiency (total cost of steam production) as shown by actual performance in similar installations.

6. OPERATION—the ability to operate continuously, the number and type of operations required, the ease of combustion adjustments, etc.

7. ADAPTABILITY—the ability to meet special and limiting conditions, present and future—structural limitations, utilization of present equipment, growth and change of power service demands.

8. FUEL FLEXIBILITY—the ability to burn efficiently and easily fuels from many sources having widely varying characteristics.

9. REFUSE DISPOSAL—the ability to economically eliminate ash or refuse and the opportunities of disposal at low cost, no cost, or profit.

10. STACK DISCHARGE—the practical elimination of "smoke nuisance" without special equipment.

11. SPACE REQUIREMENTS—the ability to conform to existing or future space limitations, to short and wide or long and narrow furnaces. Also the accessibility of component parts for maintenance and operation.

12. OBSOLESCENCE—the adaptability of the equipment toward possible future modernization with minimum of complication and outage.

A-E-CO TAYLOR STOKERS • LO-HED HOISTS
HELE-SHAW FLUID POWER • MARINE DECK AUXILIARIES

A-E-CO TAYLOR STOKER

AE CO

AMERICAN ENGINEERING COMPANY

PHILADELPHIA 25 • PENNSYLVANIA

IRON FIREMAN cuts Steam Costs 33%

After installation of Iron Fireman Stokers at BEST FOODS, Inc. steam costs dropped from 36.06c to 24.25c per 1000 pounds

BEST FOODS, INC., of Chicago, cut fuel costs one-third after installing Iron Fireman Pneumatic Spreader stokers. In actual figures, the cost for the first three months of 1943 was $14,446.71. For the same period of 1944 the cost of Iron Fireman fired coal was $9,543.91, a saving of over $1,600.00 a month for approximately the same power output. Iron Fireman maintains a steady, even steam pressure, even though steam demands for processing in the Best Foods plant are extremely variable.

Operating economy of Iron Fireman Pneumatic Spreader stokers is due to two factors: (1) The Iron Fireman Volumeter keeps the vital fuel-air ratio under constant automatic control, resulting in high combustion efficiency; (2) Ability to use a very wide range of coals, including sub-bituminous and lignite, gives a decided advantage in cost and availability of fuel to the user.

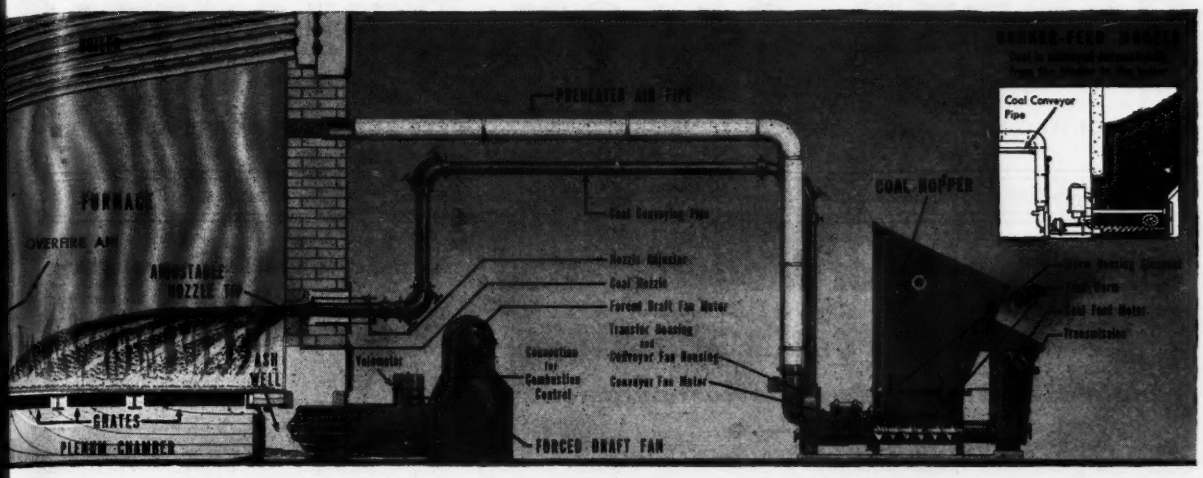
The unusual adaptability of Iron Fireman Pneumatic Spreader stokers yield further economies. Coal pick-up sections may be located anywhere within a 30-foot radius of the boiler front, or on another floor level. This saves labor, and often avoids a heavy investment in coal handling equipment.

Plants: PORTLAND, OREGON; CLEVELAND, OHIO; TORONTO, CANADA

IRON FIREMAN

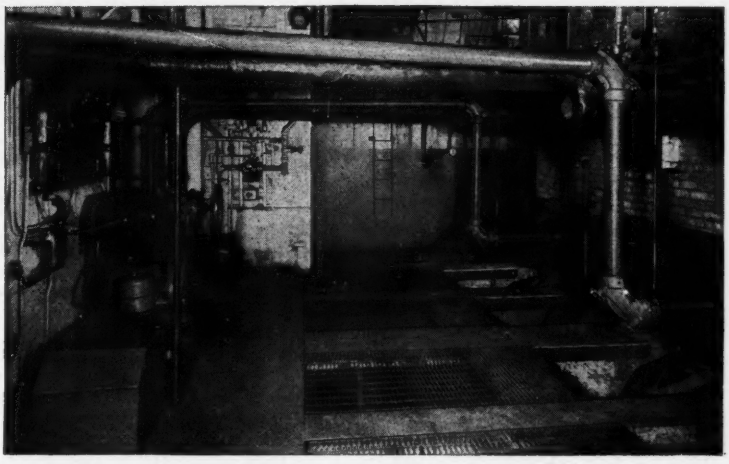
THE IRON FIREMAN

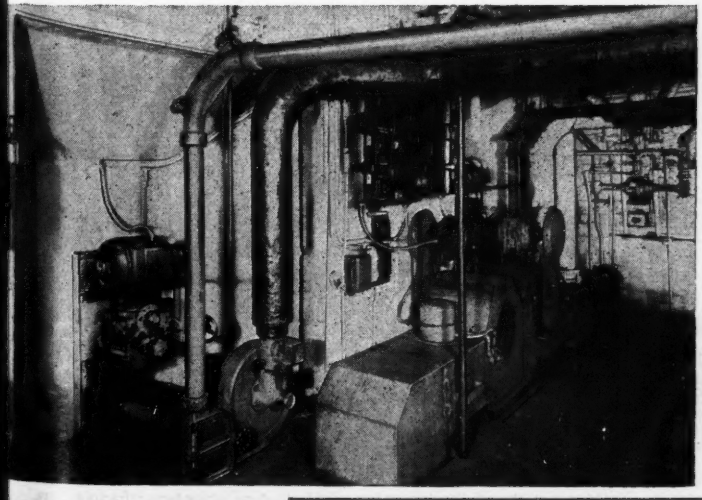
Automatic Coal Stokers



THE IRON FIREMAN PNEUMATIC SPREADER STOKER

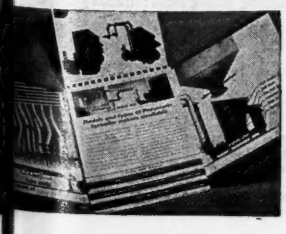
The principle of the Iron Fireman Pneumatic Spreader stoker is illustrated above. Steam size coal is metered from the hopper or main coal bunker to transfer housing, where coal is picked up by pneumatic conveyor and delivered to furnace. The conveyor nozzle accurately spreads the larger particles of coal over the entire grate in a shallow, uniform fuel bed. The preheated fines burn in suspension, reducing the cinder carry-over and greatly improving the combustion efficiency and responsiveness, as compared with other stokers which do not preheat the fuel.





BOILER ROOM IN CHICAGO PLANT OF BEST FOODS, INC.

Uncluttered boiler fronts, typical of Iron Fireman Pneumatic Spreader installations are shown above. The coal conveying pipes pass overhead, descending to the nozzle level in front of the boilers. The insulated pipe seen in both photographs is the preheated air pipe which withdraws hot gases from the upper part of the furnace for preheating the fuel. The coal pick-up sections (photo at left) feed directly from the main coal bunkers. Also visible are the forced draft fans, which in this installation are connected to the plenum chamber through underfloor ducts.



ENGINEERED INSTALLATIONS. Iron Fireman maintains a highly competent engineering staff manned by combustion engineers of long practical experience. Every Iron Fireman installation is engineered to achieve the highest possible efficiency for that particular job. Write to IRON FIREMAN MANUFACTURING COMPANY, 3295 West 106th Street, Cleveland, Ohio, for free book on Pneumatic Spreader firing. Upon request, Iron Fireman will make an engineering survey of your boiler room without obligation.

COPPER ALLOY BULLETIN

MARINE AND POWER EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared by Bridgeport Brass Company — "Bridgeport" BRASS CO. — *Headquarters for BRASS, BRONZE, and COPPER*

Plan Now For Modernization and Replacements

Time Will Be Short In Postwar Reconversion Period

Since 1939 power plant operators have felt the weight of ever increasing loads, plus the burden of wartime restriction of materials, and manpower. They have had no opportunity to modernize equipment and make necessary replacements. As the loads climbed, margins of reserve decreased until today thousands of plants are in dire need of new equipment.

New Demands After The War

When the nation begins to get on its feet after the war, the widespread return and increase of household electrical appliances, the lifting of all restrictions on illuminated advertising signs and other lighting, continued enlargement of the rural electrification projects, operation of new industries, the demands of manufacturers on peacetime production will permit power plants little time for necessary replacements and repairs. However, a let-up in power demands is expected to take place in the reconversion period when all military requirements have been met and before peacetime industry gets underway. Alert operators are determining now what steps will be necessary to modernize their plants and put them into first class condition, ready to take action while industry is converting to peacetime production.

Consider Future Requirements

When planning for modernization and replacements, the selection of condenser tubing is naturally of primary importance. Moreover, that problem will, of course, require much careful study to decide on the best tubing for present conditions, and also for conditions which may develop in the future. For example, with clean sea water an operator may have been obtaining satisfactory service from an alloy like Admiralty. But if there is a prospect of that water being contaminated in the future by chemicals and industrial wastes, a change of alloy will be beneficial.

Are water conditions likely to change for the worse? Perhaps Cuzinal (Aluminum Brass), with its resistance to dezincification and air impingement should be selected. Is there the problem of polluted, brackish water? Then DURONZE IV may be the answer. This alloy has been found superior even to Cupro Nickel for such conditions. Also, it resists corrosion from sewage and industrial wastes. If higher velocities and temperatures will be used, Cupro Nickel should be considered.

Much Progress Has Been Made

However, there is another point which power plant operators should consider. After 1939, when materials became restricted, metallurgical research uncovered many facts of interest to condenser tube users. Bridgeport has followed a consistent research program aimed toward developing better alloys with greater resistance to corrosion. Much valuable corrosion information has been collected from laboratory and field studies and from service tests carried out by operators in cooperation with Bridgeport's metallurgists.

Bridgeport will be glad to make this information available to operators who are planning now to modernize and improve their plants when the opportunity presents itself. Simply get in touch with our nearest branch office. If you do not have a copy of our 112-page Condenser Tube Manual, write for one immediately.

Duronze III vs. Naval Brass

Design engineers, by using stronger yet lighter alloys, can in many instances reduce dead weight and save space without sacrificing strength and dependability. Moreover, the new material may have greater corrosion resistance, toughness and yield strength, and thus result in longer life and a greater factor of safety.

A comparison between Naval Brass used in ship construction and DURONZE III, Bridgeport's High Strength Aluminum Bronze modified with silicon, is interesting and thought-provoking. For example, an 11/16" Naval Brass Stud used for a certain application weighs 1.35 pounds per foot and has an ultimate strength of 23,150 pounds. A stud of equivalent strength can be made from 9/16" diameter DURONZE III rod which weighs 0.827 pounds per foot resulting in a 39% saving in weight and a 33% saving in space.

On the basis of difference in yield strength, savings in weight from 48% to 53% are possible; and with breaking strength, weight savings from 36% to 42% are possible in favor of DURONZE III.

Tube extrusion press at Bridgeport. Powerful equipment is needed for making tubing from refractory alloys.

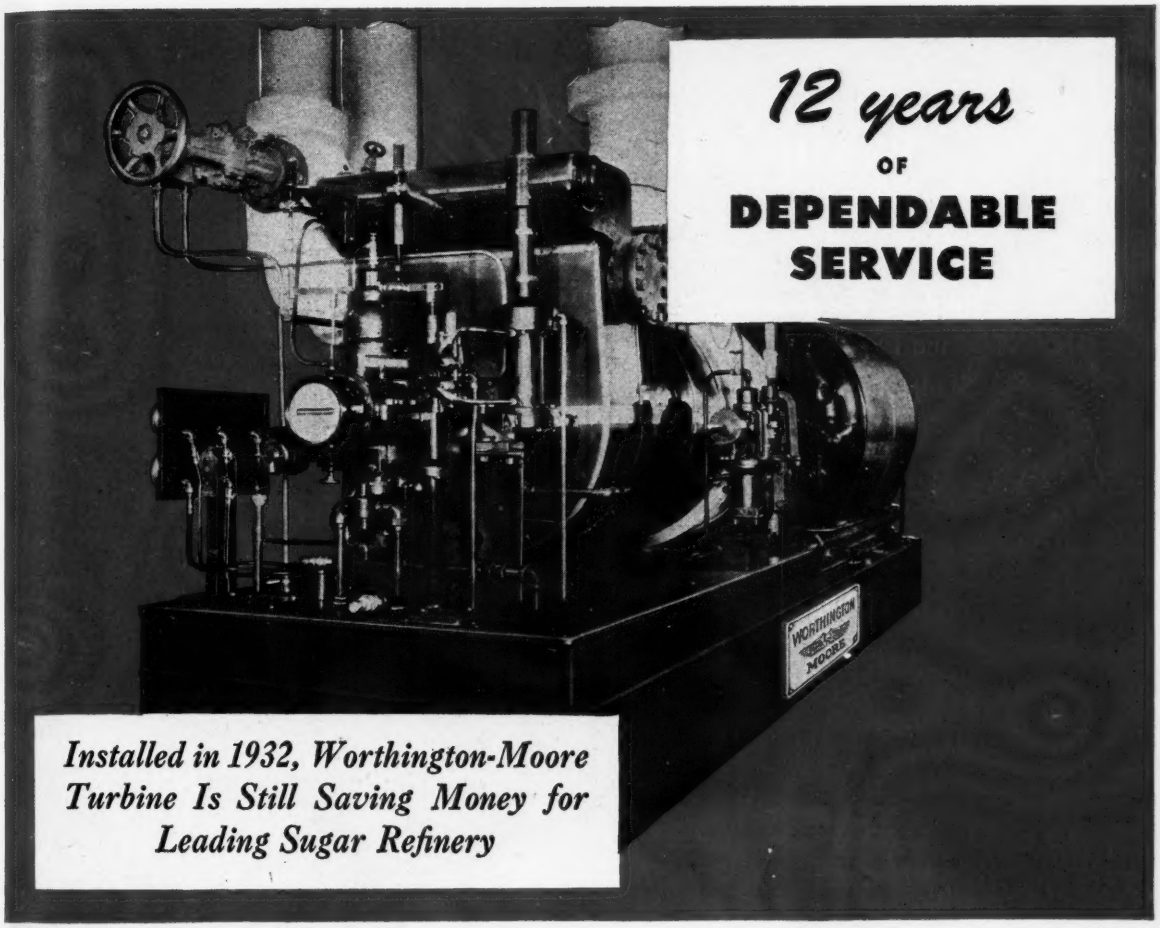
Note: Bridgeport products are supplied in accordance with existing priority regulations.

BRIDGEPORT BRASS

BRIDGEPORT BRASS COMPANY, BRIDGEPORT 2, CONN.

ARMY E NAVY

ESTABLISHED 1865



Installed in 1932, Worthington-Moore Turbine Is Still Saving Money for Leading Sugar Refinery

Dan Gutleben, engineer for the Pennsylvania Sugar Company, recently wrote: "Our Worthington-Moore turbine rolls along every day and every night without stopping. It ran for years with very few shut-downs and no service expense whatever."

Electricity a By-product

This 2000 KW turbine-generator, like many other Worthington-Moore units, produces low-cost electricity as a by-product. It operates on steam at 400 lbs. pressure, 500°F. total temperature, 12 lbs. back pressure and automatically extracts steam at 90 lbs.

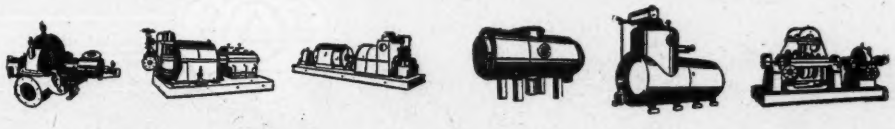
Engineering the Right Turbine for the Job

Experienced in special turbine applications, as well as in a wide range of related steam power plant equipment, Worthington-Moore engineers are especially fitted to recommend the best type of unit for your particular requirements. *Worthington Pump and Machinery Corporation, Moore Steam Turbine Division, Wellsville, New York.*

WORTH BEHIND THE NAME
WORTHINGTON
MOORE

MR4-6

A GREAT TEAM IN STEAM



EXAMPLE OF *Service*:

Adiabatic and Isothermal Compression (page 9) . . . Moisture and Dew Point (page 30) . . . Cylinder Clearance (page 10) . . . Sludge Formations (page 34) . . . These are just a few of the important subjects discussed in our handsome new booklet, AIR COMPRESSOR LUBRICATION.

Clearly illustrated, packed with helpful information, it's free to air compressor owners and their personnel.

Simply write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

More and more, it's service that counts . . .

and *Cities Service* means good service!

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CITIES SERVICE OIL COMPANY

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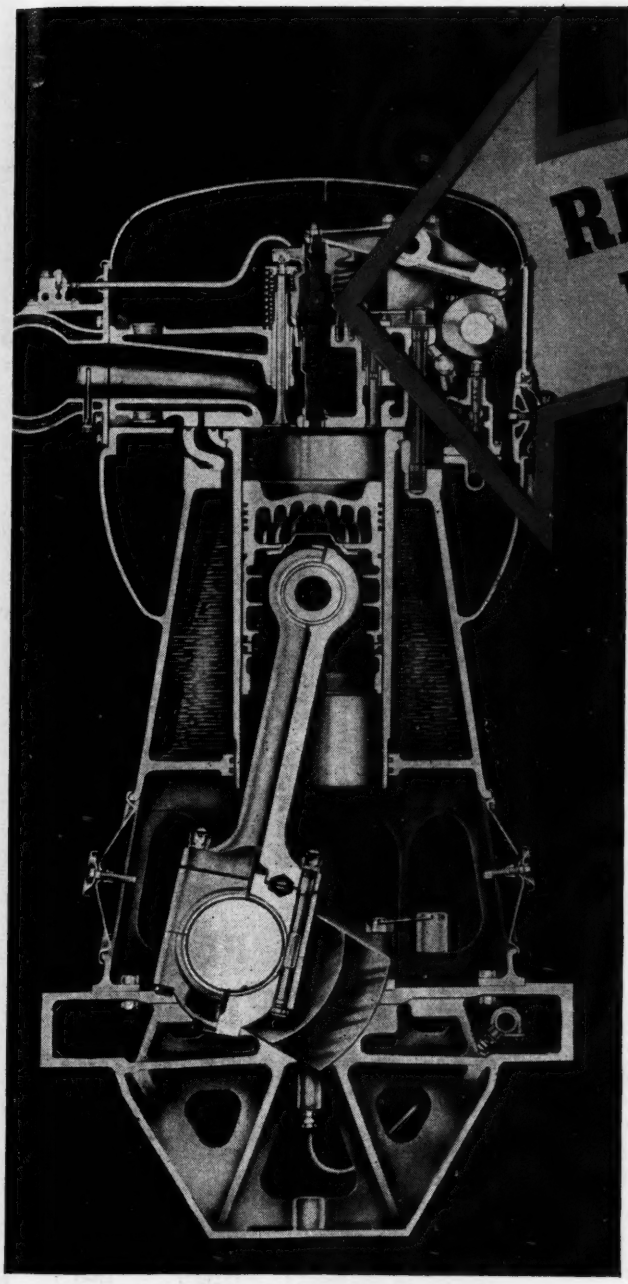


RIGHT WHERE IT BELONGS!

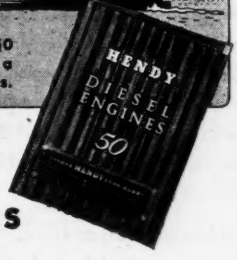
The unit-type fuel injector in Hendy Diesel Engines is right in the head...*logically* placed for satisfactory service under all load conditions, with *uniform* high-pressure fuel charge to *each* cylinder. This injection system provides individual fuel pumps for each cylinder...does away with long, high-pressure fuel lines... simplifies service because the entire unit can be easily removed for cleaning.

In addition to the unit-type fuel injector you'll find other important features too, such as...overhead camshaft, direct actuated dual intake and exhaust valves, and hydraulic tappets. All these features, *combined for the first time in a single engine,* reduce the number of wear points, simplify service and contribute directly to the lower maintenance costs a successful Diesel operator must have.

In marine service—or for stationary duty—Hendy Diesels can serve you well. They combine two great qualities...all the ruggedness for rough seas; all the good features for low-cost operation.

Hendy Diesels for marine or industrial service... 6 or 8 cylinders, 350 to 675 hp... are also available with Hendy generators as complete electric generating plants.

Hendy is currently supplying 250 kw Diesel generating sets for a large number of AVI cargo ships.



Write today for complete data—ask for the New Hendy Series 50 Diesel Engine Catalog.

JOSHUA **HENDY** IRON WORKS

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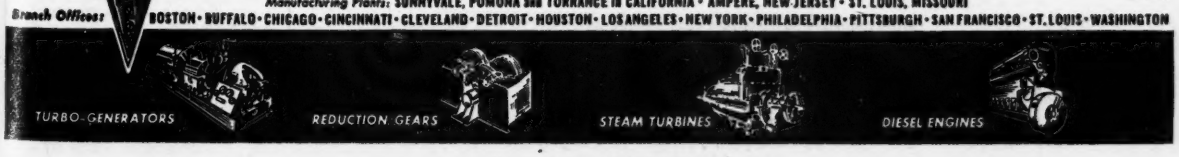

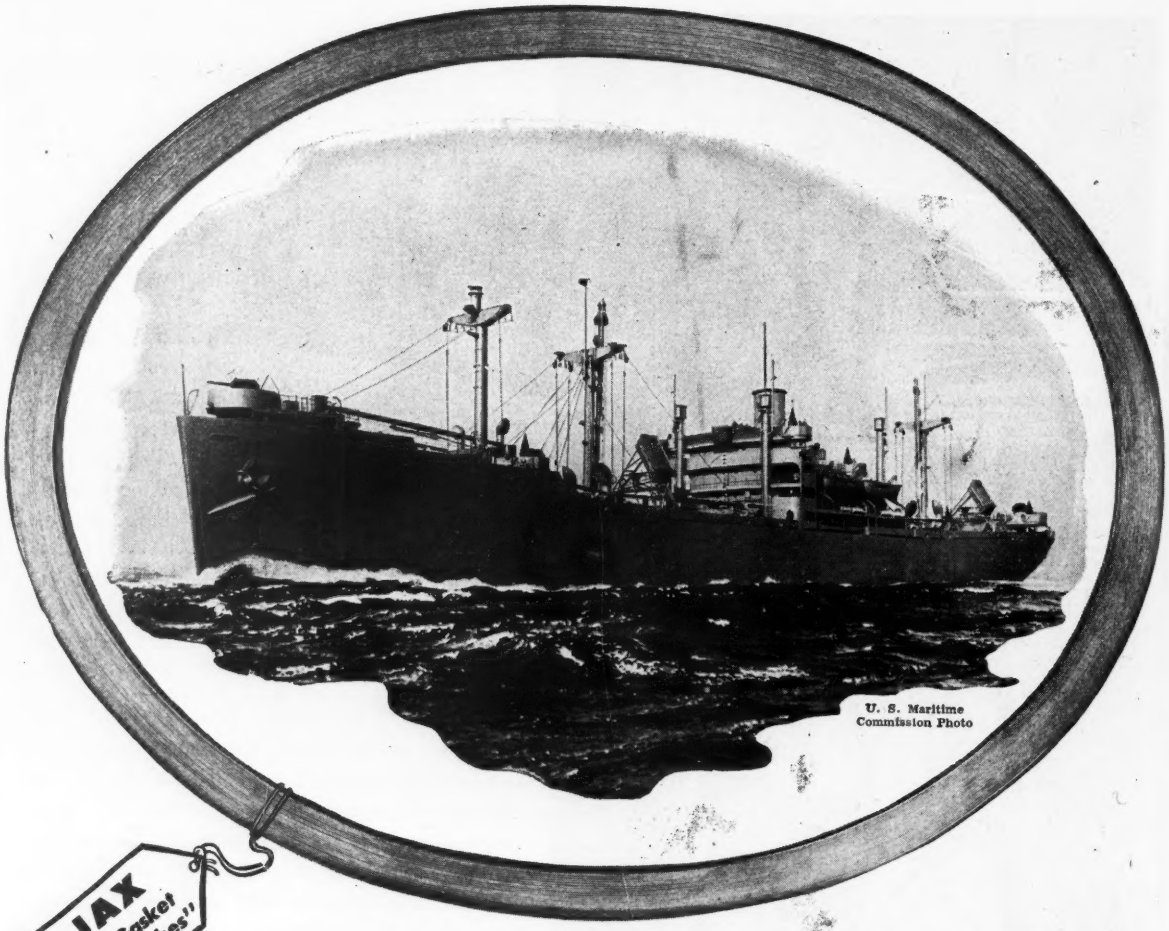

U. S. Maritime Commission Photo

AJAX "The Gasket That Breathes"

The High Pressure POWER PLANTS of the New Speedy *VICTORY SHIPS* Are Protected by AJAX SPIRAL WOUND FLANGE GASKETS

AJAX AT SEA — 17 knots an hour! 8500 H.P.! That's the story of the new United States Merchant Fleet of Victory Ships.

And AJAX spiral wound Metal-Asbestos flange gaskets are holding tight on these high pressure power plants . . . withstanding the severe shock and vibrations encountered in the heaviest kind of sea service.

AJAX ASHORE — Ajax Gaskets Are Giving Top Performance in Thousands of Stationary Power Plants.

Spiral wound AJAX metal-asbestos gaskets are made for low and high pressure service for boiler manholes, hand holes, other boiler accessories, and pipe flanges. And you'll find they give a tight leak-proof seal, are easy to install and remove, and will give trouble-free service.

Remember Ajax spiral wound metal-asbestos gaskets . . . manufactured in a modern plant on special machinery designed for high speed production and consistent accuracy. On land or at sea . . . choose Ajax and be sure.

Write today for your copy of Ajax Catalog 202

U. S. GASKET CO.

1596 PIERCE AVENUE, CAMDEN, NEW JERSEY

"THE STORY BEHIND THE GASKET THAT BREATHES"

Note on this cutaway drawing, the small air space under each U-groove in the metal ply.

There are twin strips of asbestos filler between each spiral thickness in the AJAX Gasket which cannot meet in the center under the wedge-like groove. Therefore a "breather-space" is preserved in the heart of the gasket which assures its automatic reaction to mechanical compression, to internal pressure variation, and to temperature changes.

The AJAX Gasket expands and contracts — "breathes" — with changing pressure conditions — and retains the positive, secure seal you require at all times.

Insure Better Performance

Specify Ladish *Controlled Quality* Forged Steel Pipe Fittings

Ladish forged steel fittings, carbon and alloy, are produced under exacting metallurgical control. Every Ladish fitting bears the symbol of Controlled Quality—the Ladish Heat Code.

Forged Steel Screwed Fittings

Full depth thread, accurately cut, results in pressure-tight joints. Pipe enters easily. Uniform thickness. Sizes clearly marked . . . ⅛" through 4".

Socket Welding Fittings

Speed up installation because deep sockets save time formerly required to cut pipe to exact length. Socket supports pipe and allows self-alignment. No machining of pipe necessary for fit. ASSURED WELDABILITY. Sizes clearly marked . . . ⅛" through 4".

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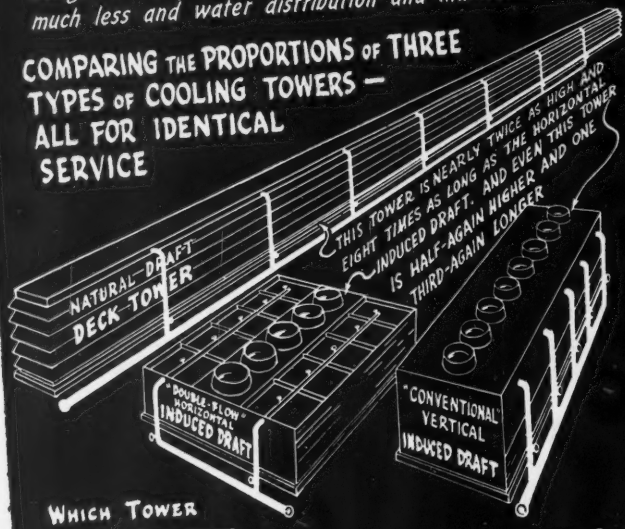
Cooling Tower DOs and DON'Ts
-by MARLEY (No. 5 of a series)

POINTERS ON CONSTRUCTION

In purchasing or evaluating any cooling tower these particulars of construction deserve attention:

GENERAL DESIGN—Towers of broad-and-low proportions are preferable over high-long-narrow designs. They can be better braced, their requirements for pumping, foundation and basin are much less and water distribution and maintenance are simplified.

COMPARING THE PROPORTIONS OF THREE TYPES OF COOLING TOWERS — ALL FOR IDENTICAL SERVICE


NATURAL-DRAFT DECK-TOWER
THIS TOWER IS NEARLY TWICE AS HIGH AND EIGHT TIMES AS LONG AS THE HORIZONTAL INDUCED DRAFT, AND EVEN THIS TOWER IS HALF-AGAIN HIGHER AND ONE THIRD-AGAIN LONGER
"DOUBLE-FLOW" HORIZONTAL INDUCED DRAFT
"CONVENTIONAL" VERTICAL INDUCED DRAFT

WHICH TOWER
IS THE SOUNDEST
STRUCTURE, LEAST VULNERABLE TO WIND OR QUAKE?
WHICH REQUIRES THE LEAST PIPING AND PUMPING?
WHICH CAN BE MOST CONVENIENTLY LOCATED AT MOST PLANTS?

REDWOOD vs. STEEL—Redwood is the principal structural material in all but a small fraction of the total cooling tower capacity installed today. In towers of more than a few hundred GPM, steel is rarely to be preferred. Steel costs more, its service life is not as long, general maintenance greater. It requires frequent and liberal painting with aluminum-base paint inside and out to retard corrosion, whereas Redwood's natural preservatives render painting unnecessary. However if a Redwood tower *is* painted (for color harmony or to carry an advertising sign) it requires only standard paint, only infrequently, and only on the outside. Fire and safety ordinances which once banned any wood structures on roofs in business areas of some cities now have been modified widely in the case of Redwood due to its proven resistance to burning, its retention of strength in defiance of age and weather, its freedom from all forms of organic attack.

FRAMING—Equally as important as proper size, quality and quantity of members is that connections be sound, snug-fitting, full-bearing, with proven timber connectors (such as "Teco" rings) at critical joints; and footings, angle-washers and other structural hardware as required. Unit working stresses and other values should conform to recommendations of the U. S. Forest Products Handbook. Bolts should be used throughout, with no dependence on nails and no credit for structural strength given to the casing or other non-frame parts.

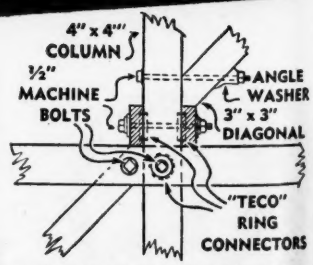
CASING—Walls should be double, with air space between, or otherwise provide for internal drainage of water on the inner surfaces to avoid seepage and unsightly exterior staining. Casing should be applied in a manner to permit necessary expansion and contraction without stress to frame or casing, and to present a smooth, neat exterior.

SAFETY & CONVENIENCE—Adequate stairs, ladders, walks, doors, guards and railings should be provided for safe and convenient access to all parts of tower requiring inspection and service.

MARLEY COOLING TOWERS

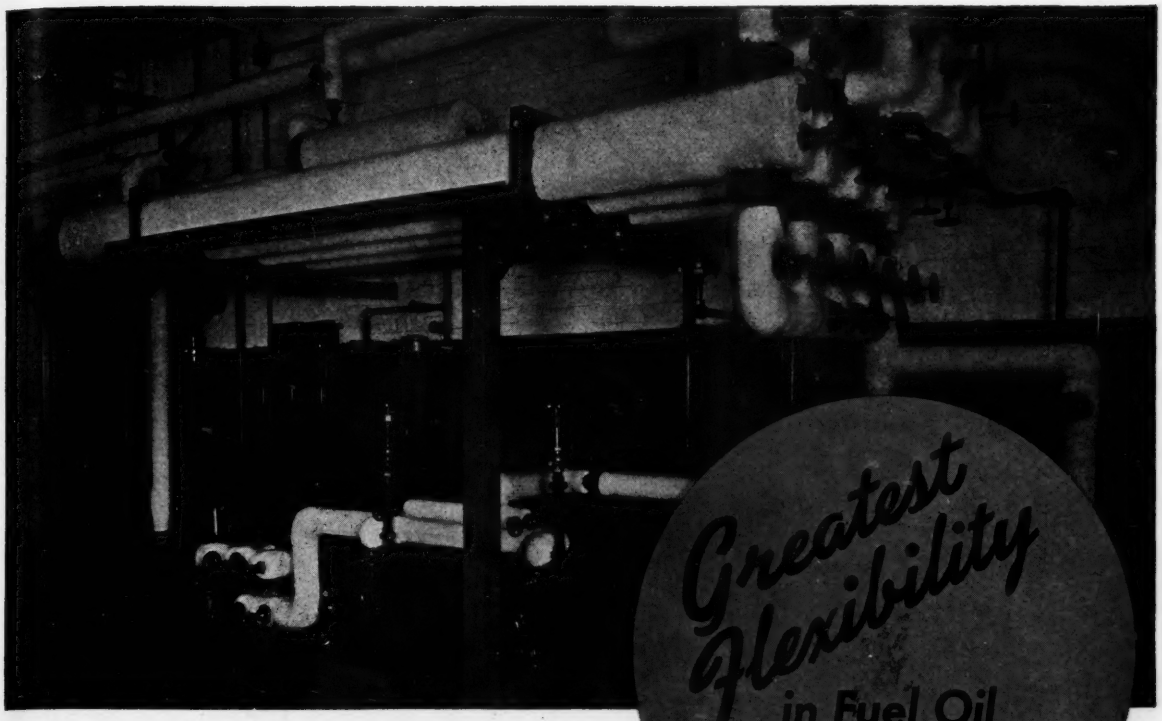
94-A

DO YOU KNOW— snug fit, full bearings, uniform workmanship and sound materials are assured in all frame members and other Redwood parts of Marley towers by 100% *pre-fabrication* in Marley's two large wood-working plants (Stockton, Calif., and Kansas City, Kans.) thoroughly equipped for this exacting service. Marley's structural superiority is a recognized fact, zealously maintained.



TYPICAL MARLEY FRAME JOINT

THE MARLEY COMPANY, INC. · KANSAS CITY · KANSAS



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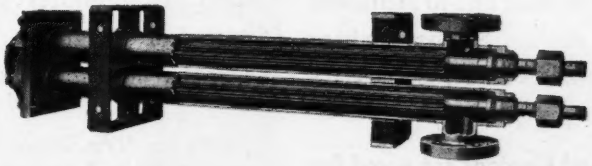
in Fuel Oil Heating Installations

TWIN G-FIN SECTIONS...

These standard, interchangeable, compact heating units can be placed wherever convenient . . . connected in series or parallel for desired capacity and heating effect.

Individual units can be cut in and out of the line to maintain constant oil temperature at fractional loads . . . unused units can be inspected or cleaned without shutting down the entire heater installation . . . these are some of the reasons why TWIN G-FIN SECTIONS give GREATEST FLEXIBILITY in fuel-oil heating installations.

Write for Bulletin



The Griscom-Russell Co.
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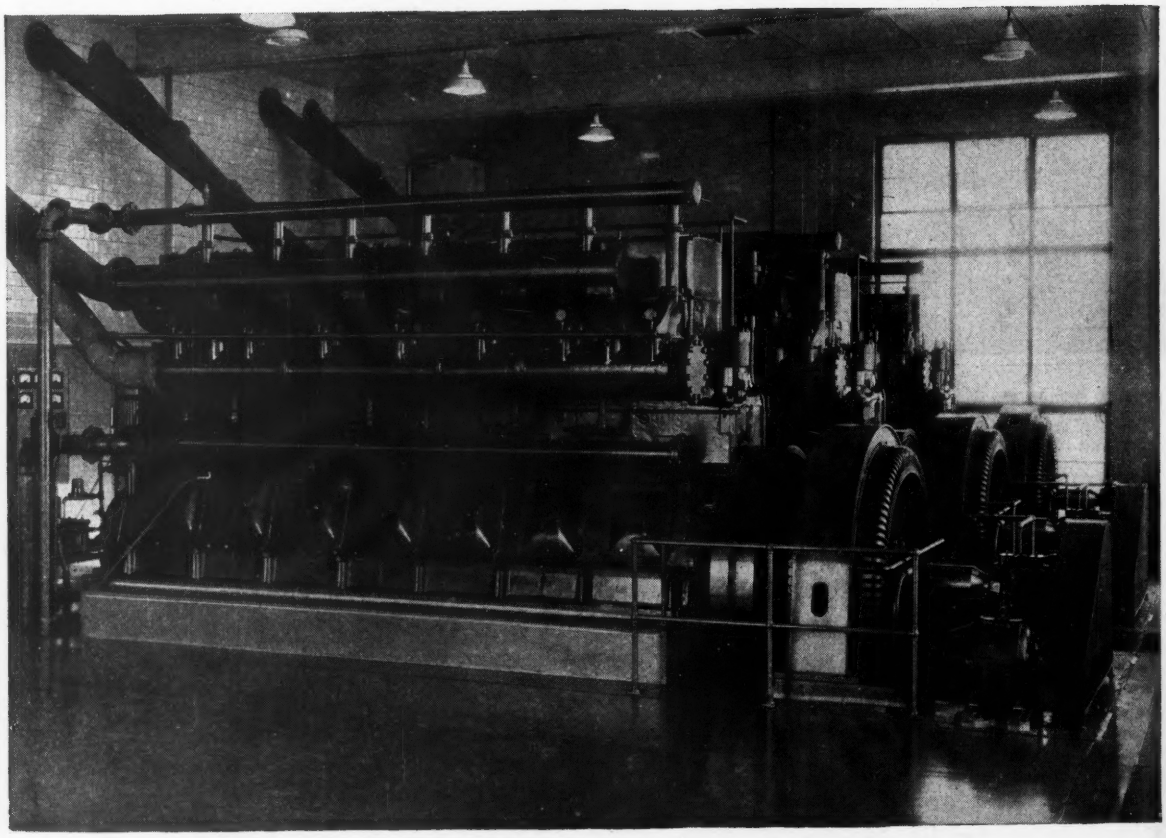
GRISCOM-RUSSELL

Pioneers in Heat Transfer Apparatus

BETTER *Lubrication* Means Better Maintenance



Is difficult maintenance a problem? Maybe excessive wear due to inefficient lubrication is the cause. That's where SINCLAIR RUBILENE and GASCON OILS can help.

Rubilenes and Gascons are noted for great film strength and high stability. They stand up under highest temperatures and pressures . . . give ring-free, port-clear operation . . . promote clean, efficient running and longer service life.

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(Write for "The Service Factor"—published periodically and devoted to the solution of lubricating problems.)

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FOR FULL INFORMATION OR LUBRICATION COUNSEL WRITE SINCLAIR REFINING COMPANY, 630 FIFTH AVENUE, NEW YORK 20, N. Y.

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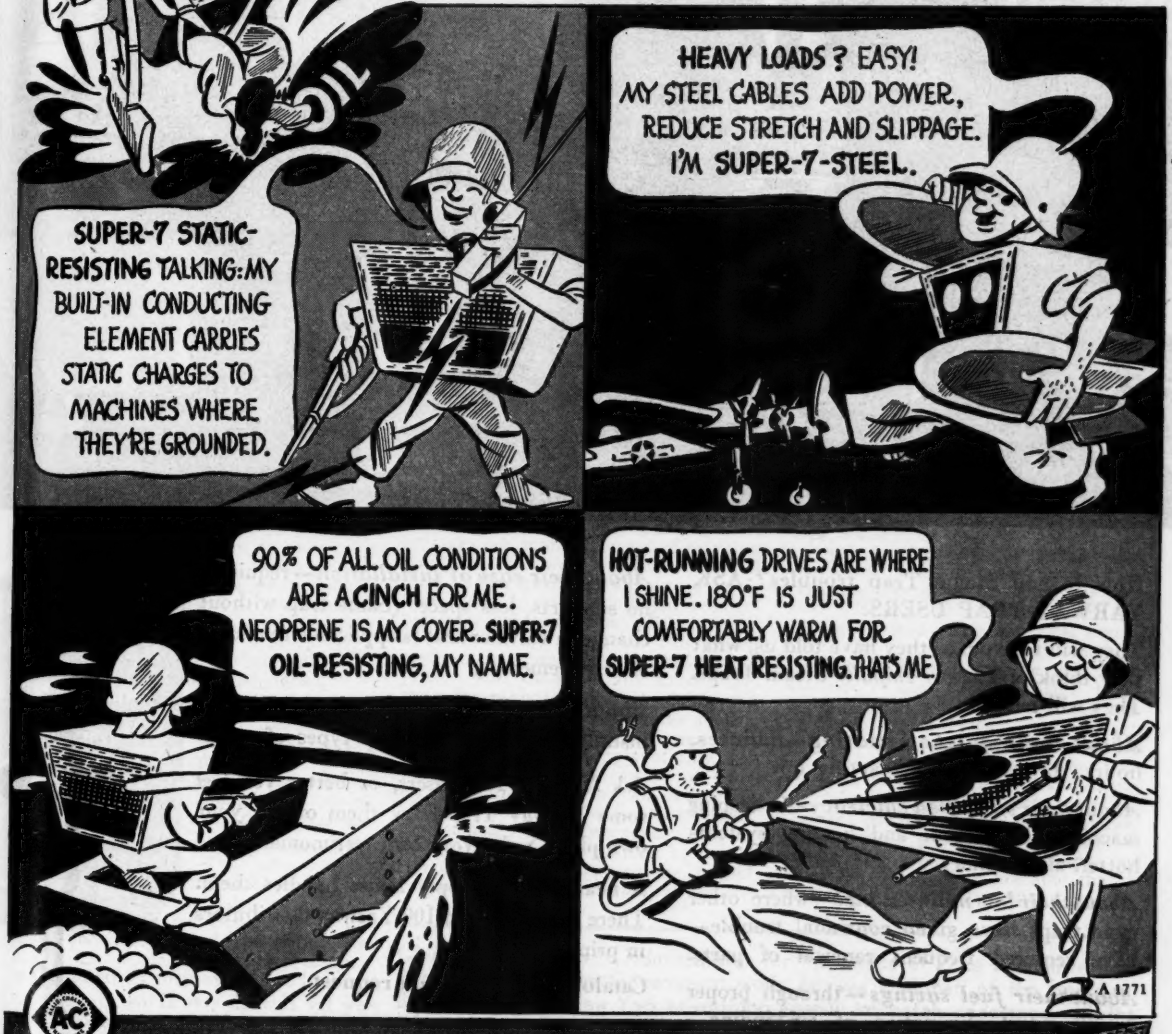
YOU'RE SURE TO GET TOP-FLIGHT DRIVE PERFORMANCE WHEN YOU SPECIFY ALLIS-CHALMERS TEXROPE V-BELTS . . . EACH BELT IS DESIGNED, TESTED AND BUILT TO SOLVE SPECIFIC DRIVE PROBLEMS

♪ *Tune in the Boston Symphony, Blue Network, every Sat. Eve.*


REALLY BAD OIL CONDITIONS ARE MY OBJECTIVES. I'M SUPER-7 OIL-PROOF...MADE OF SOLID NEOPRENE. GRIMY LIQUIDS DON'T BOTHER ME.
SUPER-7 STATIC-RESISTING TALKING: MY BUILT-IN CONDUCTING ELEMENT CARRIES STATIC CHARGES TO MACHINES WHERE THEY'RE GROUNDED.
HEAVY LOADS? EASY! MY STEEL CABLES ADD POWER, REDUCE STRETCH AND SLIPPAGE. I'M SUPER-7-STEEL.
90% OF ALL OIL CONDITIONS ARE A CINCH FOR ME. NEOPRENE IS MY COVER...SUPER-7 OIL-RESISTING, MY NAME.
HOT-RUNNING DRIVES ARE WHERE I SHINE. 180°F IS JUST COMFORTABLY WARM FOR SUPER-7 HEAT RESISTING. THAT'S ME.
A 1771

IT PAYS TO MAKE **ALLIS-CHALMERS** YOUR

V-BELT DRIVE HEADQUARTERS

Texrope Super-7 V-Belts result from the cooperative research of two great companies—Allis-Chalmers and B. F. Goodrich—and are sold exclusively by A-C.

Bright Spots *in a* Plant Operator's Life

How to end Steam Trap troubles? ASK YARWAY TRAP USERS.

They will tell you, as they have told us, what they think of Yarway *Impulse* Steam Traps. They will tell you:

About their quicker heating—minutes, hours, days, saved in starting up.

About their sustained efficiency—in keeping machines, equipment and heating systems hotter, all the time.

About their low maintenance—where other type traps have given continual trouble—have required frequent renewal of parts.

About their fuel savings—through proper draining and elimination of air-binding—through less radiation loss due to this trap's small size.

About their ease of installation—requiring no supports, less space. (Same trap without change in valve or seat is applicable to almost all requirements.)

About their low price—often costing less to install than to repair other types of traps.

Ask Yarway Trap users, or better yet—*get* some Yarway Traps, try them out in your own plant, write your own testimonial.

A near-by mill supply house handles them. There are more than 100 Yarway distributors in principal cities.

Catalog T-1738 sent on request.

YARNALL-WARING COMPANY
114 Mermaid Ave., Philadelphia 18, Pa.

YARWAY IMPULSE STEAM TRAP

WHAT LEADERS SAY

Let's Avoid an Inventory Boom—and Collapse

By CHESTER BOWLES

George Maillard Kesslere Photo

IF WE HAVE THE COURAGE and wisdom to make full use of our experience in holding prices steady during the past few years of unprecedented inflationary pressures, and if business lends its full cooperation, our economy need not go on a roller coaster ride after this war—a roller coaster ride that would carry prices swiftly higher and then drop them even more rapidly.

America is a strong nation today. It has attained a production record never before equalled. Employment, income and savings have reached all-time highs. These assets can be wisely used to the advantage of the nation but they can also result in the strongest inflationary pressures that we have ever faced. If we use these assets wisely by combining them with the vast experience and knowledge we have gained during wartime, we should be able to look forward to a peacetime of high production and full employment.

In preparing plans for a quick conversion to production of civilian goods, the War Production Board has announced that it will lift controls over most materials immediately after the defeat of Germany except for a simple preference rating system to assure no possible impairment of military production for the Japanese war. Indications are that there is available a supply of materials, components, facilities and manpower to achieve large civilian output without detailed priorities regulation from Washington.

We in the OPA welcome this development. It will help in the problem of holding prices stable. Naturally, the quicker the supply of scarce goods is replenished and supply is more evenly balanced with demand, the easier becomes the problem of price controls.

We in the OPA have been asked by some business men if we are contemplating action to eliminate price controls over the materials that WPB frees. Much as we would like to do this, such a step would be impossible at this time when inflationary pressures are as great as they ever have been.

The problem is very difficult but we are working out plans so that price controls can and will be relaxed in one commodity field after another just as soon as there is no longer any danger of increasing prices in the particular field. Obviously we must continue to hold the line against inflation in each field until that stable balance of supply and demand is attained. An economy of high production and full employment cannot be built on unstable prices and costs.

One of the worst evils during the period of rising prices in the 1919-20 period was the mad scramble for inventories by manufacturers and by out-and-out speculators.

Then the value of these inflated inventories collapsed with the price structure. In cold dollars and cents, the inventory losses in 1920-21 totaled 11 billion dollars. These losses wiped out practically all corporate reserves accumulated out of war-time profits.

A similar disastrous speculative spree—and it could be far worse this time—must be avoided. We in the OPA are determined that it shall be avoided. We are going to see that as materials are freed there is no reason for one person to bid against another because of fear that he must protect himself against speculative rises in the price structure. Furthermore, the WPB has announced that it will maintain its organization and powers to make certain that no one is permitted to procure an unreasonable amount of any materials or product.

These safeguards should effectively prevent an inventory boom such as that which contributed to the inflation and depression of 1918-21.

Price control, through the assurance of stable prices, makes the existing supply available to all. For instance, let's say ten manufacturers of washing machines each need ten tons of rolled steel. The available supply is more than equal to their combined requirements of 100 tons. They all know that a price ceiling exists on this rolled steel so that none needs to bid up the price. Also, the speculator knows that the price cannot legally go higher and that there is no shortage in the supply. The result: Each manufacturer, confident of an ample supply of raw material at stable prices, aware of what his inventory is worth, can devote his attention to production and distribution requirements of his business.

Another influence helping to supply civilian needs until peacetime output reaches the desired volume is the release of surplus stocks by the armed forces.

An economy based on stability of prices, provided that the prices of finished products are "right," is an economy that can lead to large production, large distribution and large consumption.

To those in the distributing field this is highly significant. To distributors, high production, full employment and full distribution mean more sales and more dollars for them to bank as a result of the greater number of units handled.

None of us, I am sure, wants to go back even to conditions as they existed in 1940. Let me illustrate what that would mean. The U. S. Department of Commerce in a recent publication said that if, in 1946, we no more than match our 1940 production levels, that would mean a cut of more than 30 per cent below our present level of production. Taking into account technological advance since 1940 and the increase in output per man hour, production at this level would result in the shocking figure of 19 million unemployed.

On the other hand, if we attain full production with corresponding increase in national purchasing power, the Department of Commerce puts the results in these concrete terms: There would be 40 per cent more food consumed than in 1940—not in calories but in expenditures for a more varied diet, for better qualities and for increased services in connection with processing and distribution of food products. There would be 45 per cent more clothing, 55 per cent more refrigerators and other electrical equipment, 70 per cent more household furniture, 90 per cent more new farm machinery and two-and-a-half times the number of new home buildings constructed than in 1940.

By the same cooperation as we have had in wartime American business men can look forward with confidence to this reconversion period, certain that the great resources of this nation can build a peacetime structure as strong and capable of achieving our goals as the wartime machine that is carrying us to ultimate victory.

CHESTER BOWLES is Administrator for the Office of Price Administration. Prior to undertaking Government work, he was chairman of the board of Benton & Bowles, New York advertising agency intimately concerned with the advertising and merchandising of consumer products of such companies as Procter & Gamble, Best Foods, Pepperell Mfg. Co. Mr. Bowles left his firm in 1941 to become Connecticut State Rationing Administrator, became Connecticut State Director of OPA in May, 1942 and was appointed to his present post in 1943. He has prepared this article, through Business News Service, exclusively for POWER PLANT ENGINEERING and other BNS members.

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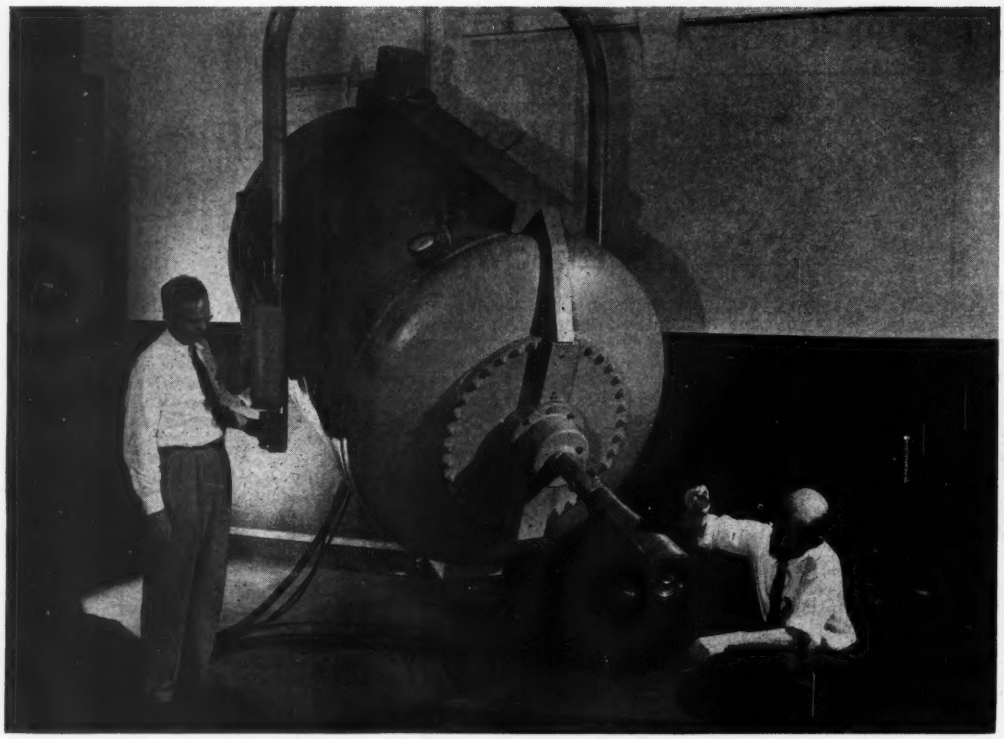

Through a Foot of Steel

USING a new two million-volt mobile X-ray unit developed in the Research Laboratory of the General Electric Co. at Schenectady, X-ray pictures can now be taken through pieces of steel a foot thick. This doubles the voltage of X-rays available to industry for examination of metal sections to find defects. In radiographing an 8-inch steel casting, the two million-volt outfit is 78 times as fast as the million-volt unit. Under one typical set of conditions four and a half hours were required to make an exposure through this thickness with a million volts. Two million-volts did it in three and a half minutes. For thicker sections the ratio is even greater. Two million-volt X-rays make a satisfactory exposure through a foot of steel in about two hours. For practical purposes such a thickness is opaque to million-volt X-rays.

Though the new unit weighs 5000 lb, it is mobile in the sense that it can readily be moved by crane and placed in position at any angle by push-button control of fractional horsepower motors. Steel castings of the thickness for which it would be used might weigh hundreds of tons and where such masses are handled a 2½-ton X-ray outfit is relatively light.

Like the million-volt apparatus, the new two million-volt unit makes use of a multiple-electrode tube, in which the electrons, starting from a heated cathode at the top, are speeded up in stages until they have the total rated energy. After they attain full speed, which for two million-volts is about 179,000 miles per second or 96 per cent of the ve'ocity of light, they strike a copper-backed tungsten target at the end of the tube and X-rays are generated. These may be squirted from the end, like water from a hose, or sprayed from the side. After penetrating the metal specimen, they fall on the photographic film which makes the radiograph.

The acceleration of the electrons is effected in 24 stages, averaging 83,500 v at each stage. High voltage is supplied by a resonance transformer built around the tube itself. A resonance transformer is different from the conventional transformer in that it has no iron core, hence it is possible to place the tube in the center of the transformer itself. This results in a very compact design. Both tube and transformer are enclosed in a metal tank filled with Freon gas for insulation.

WITH THE EDITORS

◆ **National Electronics Conference**—If attendance meant anything at the National Electronics Conference, the crowds that thronged the halls and public rooms of the Medinah Club in Chicago during the three days of October 5, 6 and 7, provided ample evidence that people are interested in the subject of electronics. Getting into the meetings the first morning of the Conference was like trying to get on a New York subway train during the rush hours. The place was, literally, packed with people—men and women from near and far, representing every branch of industry, all talking, thinking, almost radiating *electronics*. The so-called advance registration desk, was besieged with long lines of patient, semi-patient and some impatient registrants, extending almost to infinity—at least into the elevator lobby. At the first "jam" session, it was announced that there were over 1400 registrants at that time. Before the Conference ended this figure reached slightly over 2150. This was a larger attendance than has ever been attained at any one of the National Engineering Society Conventions.

That evening, at the dinner, Major Lenox Lohr, former president of the Century of Progress and now president of the Museum of Science and Industry in Chicago, gave an interesting address, entitled "Triggers to Mass Action". This dealt with the sometimes strange and unexpected behavior of people in the mass—of crowds, and the impulses underlying such behavior. He suggested that there may exist, as yet, unknown and unexplainable "triggers" to such mass action.

In some ways it seems to us the Conference itself was a splendid example of such mass action; someone had whispered the trigger word, *Electronics*, and this was the result—hundreds of people, curiously, ambitiously, almost frantically trying to get on the electronics band wagon.

Now, this seems strange. There is nothing particularly new about electronics; it has been with us for over a quarter of a century. The pages of technical books and magazines, the communications field journals, the proceedings of technical societies are replete with hundreds and thousands of articles on electronics; the entire modern communications field, rests upon a rock-bottom foundation of electronics; thousands of industrial plants throughout the country have used electronic applications of various kinds for a score of years. Yet, here in Chicago, we find hundreds of people, many of them experts in electronics, almost clamoring to participate in this electronics conference. Why was this; why did they come?

◆ **Why they came**—Many of them, of course, came to learn something and, no doubt, all who attended the Conference did learn something, but the fact remains that most of these people who came already knew a great deal about electronics and they must have known about many of the things presented at the Conference. Many of the developments and applications described in the papers of the conference, previously had been presented in print in technical and semi-technical publications and in greater detail, no doubt, than could be described in the limited time at the disposal of the speakers. Naturally, there were announcements and descriptions of new developments—the 2,000,-000 v mobile X-ray unit shown on the opposite page for example—but as a whole, the papers dealt largely with subjects which must have been perfectly familiar to a large proportion of those attending the meeting.

Many, of course, came for the personal and social contacts which a public conference affords. Some no doubt, came for more or less selfish reasons; for the prestige it would give them or their companies. Professor Karapetoff, once described the various classes of people that attend engineering conferences. There is, for example, the company representative who must make himself heard so as to advertise his company. There is also the company representative who comes with a prepared discussion criticizing his competitor's paper. Then there is the erudite young man who wants to exhibit his mathematical prowess by filling a couple of blackboards with equations which nobody understands; and so on. This being a typical meeting, there were probably some from all categories at this Conference.

◆ **Bad P. A.**—These remarks constitute no criticism of this Conference in particular. On the whole it was an interesting and what an advertising man probably would have called a "dynamic" meeting. It would have been a more comfortable meeting if there had been less people, or if there had been more room. The rooms were too crowded, the projection screens too far away from most of the audience, members were crowded too close together at the luncheons and dinners and, quite typically, the public address systems were pathetically bad. At the opening session, where Ralph Beal, Assistant to the Vice President in Charge of R.C.A. Laboratories addressed the convention, the amplifiers were noisy and the P. A. system would go off into a sustained howl at the least provocation. It has been our observation that, where such P. A. systems would scarcely be tolerated at a haberdashers' convention or a meeting of the butter and egg fraternity, at an electronics meeting attended and run by people who are supposed to be experts in P. A. work, such systems are not only permitted to remain on the scene but are nursed and cajoled into some semblance of performance with the utmost patience and apparent unconcern. In this case, the feedback tendency was partially corrected later on in the program but it should have been in perfect shape before the meeting opened.

Such things, while of minor importance, nevertheless can do much to add or detract from the success and effectiveness of a convention. Aside from the irritations they cause, much time is consumed, needlessly in attending to matters which should have been done beforehand. In this particular case, much time was lost because of inadequate facilities—meeting rooms had to be cleared of luncheon tables before afternoon sessions could be held. As a consequence there was little time left for discussion of many of the papers. Quite obviously, the attendance was far larger than those in charge of arrangements had anticipated but this does not necessarily relieve them of the responsibility for the "sardine" aspect of the meeting.

The people attending the Conference came from all sections of the country and their interests were about equally divided between the communication and industrial field. The Army and Navy was well represented and there were quite a number of women. Peripatetic "gobs" from a local naval training school, with walkie-talkie sets lent atmosphere to the proceedings. They wandered around, from room to room, and from floor to floor talking to each other on their high frequency gadgets with the greatest nonchalance.

The electronic wire recorder also was a minor feature of the conference. It brought to the meeting a part of the battle of Saipan, and at the dinner meeting on Thursday there were two electronic wire recordings of talks by Maj. Gen. Inglas, Chief Signal Officer of the Army and Rear Admiral Redmass, Director of Naval Communications.

◆ **Why, so long?**—Dr. W. C. White of the General Electric Electronics Laboratory gave an interesting talk at one of the luncheon meetings which has a bearing on these remarks concerning interest in this conference. Although his address was entitled "Electronics in Industry" he said it really should have been "Why Has It Taken So Long?" As he pointed out, he saw high frequency induction heating in the laboratory over 20 yr ago. There was nothing complicated about it and its use was obvious yet it took almost 20 yr to get it out of the laboratory into industrial production. "Why," he asked, "has it taken so long?" The same, he pointed out, applied to electronic motor control. These could have been brought out 5 yr ago. In the application of the heavy duty rectifier, Dr. White indicated we had displayed the same lethargy. There were two main reasons for this, first, mental stagnation augmented by business depression and second, our inherent tendency to resist change. Our real competitor in the commercial development of all such things, he said, "is doing it the old way".

To develop electronic equipment, Mr. White said, you need field experience and that is difficult to get. People do not like to take a chance on new things and they were extremely reluctant to adopt the use of tubes. They expected highly perfected, foolproof equipment too soon.

These remarks of Dr. White regarding the use of electronics in industry apply equally well to the present long-delayed general interest in electrons. Electronics is not new, yet it has taken more than a quarter of a century for people to display a general interest in it.—A. W. K.

Pennsylvania Edison Adds 3

One 300,000-lb-per-hr, 880 psi, 900 F pulverized-coal-fired boiler, one 35,714-kva, 0.7 pf turbine generator . . . Boiler design for 88.35 per cent efficiency . . . Two-section air preheater, compact fan layout . . . Combination steam temperature control . . . Coal silos and good coal-handling layout . . . River used as spray pond . . . Direct contact feedwater heaters . . . Flood proof construction . . . All major equipment on one level, centralized control, partitionless building . . . Open, simple design contributes to ease of operation

ONE OF THE FEW new central station generating plant additions to be installed during the latter part of the war has just been placed in operation at the Williamsburg Station of Pennsylvania Edison Co., at Williamsburg, Pa., on the Juniata River, about 20 miles Southeast of Altoona, Pa. This unit, rated at 35,714-kva or 31,250-kw at 0.875 pf, 25,000-kw at 0.7 pf, is a single 880-psi, 900-F, one-boiler one-turbine addition. This increases the plant to 244 per cent of the capacity of the existing station, where the capacity has been vitally needed to assist in carrying the heavy war loads in that section of Pennsylvania.

Principal Features of Extension

Principal characteristics of the new addition, to be discussed in more detail below are: Simple, convenient layout of equipment and centralization of control for ease of operation; simple coal-handling system, with silos forming one end wall of building; single 300,000-lb-per-hr pulverized, coal-fired steam generating unit with convenient steam temperature control and unusual layout of high and low temperature air preheaters, fans and stack; new 31,250-kw turbine, driving hydrogen-cooled 3600-rpm generator; ingenious use of river above dam as spray pond to insure adequate supply of cool condensing water at low water periods in river; use of direct-contact feedwater heaters and multi-section condensate pumps; heat balance with 5 bleed points for evaporation and feed heating integrated with that of existing station, with steam tie line to supply steam from new high-pressure, high-temperature boiler to older low-pressure units if necessary or desirable; watertight basement for new addition to protect against flood damage; heat balance and general design for high economy.

General Design Background

The Williamsburg Station, before its enlargement, contained three turbine-generator units, one of 8000-kw and two of 5000-kw capacity, a total of 18,000-kw operating on 185 psi steam generated by 9 stoker-fired boilers. This station, together with the Saxton Station of the company, which has an installed capacity of 62,500-kva, serve a vital industrial district surrounding Altoona, containing a number of essential industries. In 1940, because of the expansion of those industries, it was thought advisable to expand the Williamsburg Station and one plan considered was the installation of a high-pressure topping unit superimposed on the low-pressure units. However, it was finally found advisable to install the additional capacity in a condensing unit, as an addition rather than a top.

Space has been provided for a topping unit in the building of the turbine room and engineering completed for this topper and a 350,000-lb-per-hr boiler and will be carried out later. Such a topping unit, with the existing low-pressure units and the new 30,000-kw addition, would provide over 60,000-kw of firm and very economical capacity at this point on the system where it is vitally needed.

In 1940, the Pennsylvania Edison Co. engaged the consulting firm of Burns and Roe, Inc. to prepare studies and designs for the Williamsburg extension. The turbine-generator and steam generator orders were placed in 1941 but because of priority rulings these units were not completed until this year. Actual plant construction work began in the fall of 1942, but it was late in 1943 and the first part of 1944 before the priorities permitted most of the equipment to be obtained, after which the work went forward rapidly, all the equipment being installed in June, 1944. The preliminary operation and "tuning-up" of the new unit then began and it is now in full operation.

The principal characteristic noted on inspecting the Williamsburg addition is the simplicity of arrangement, the open and uncluttered appearance of the main operating floor and the centralization of all major equipment and its controls on this floor. The resulting convenience of operation makes for good station performance by making it easy for the op-

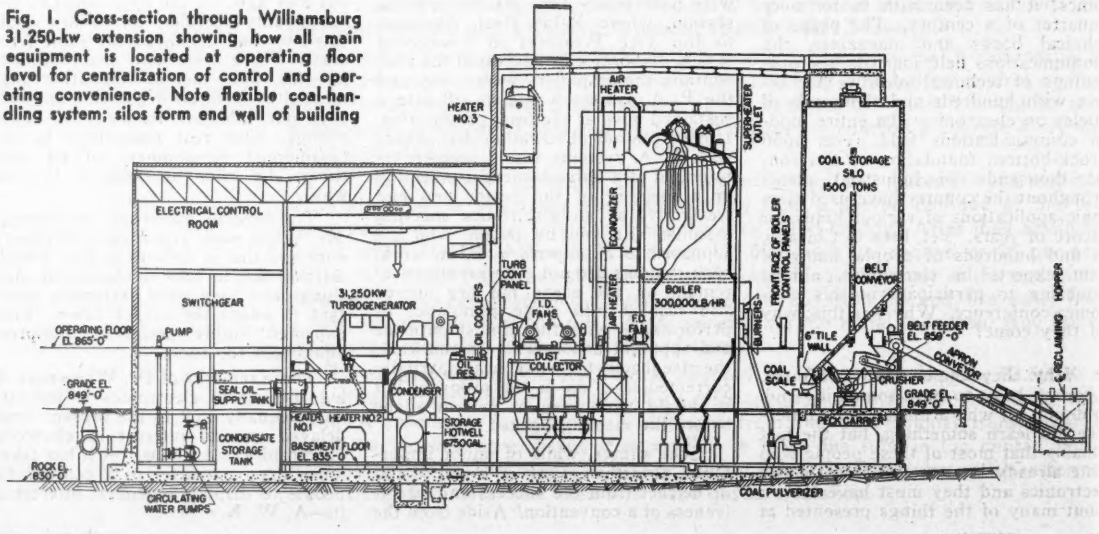

Fig. 1. Cross-section through Williamsburg 31,250-kw extension showing how all main equipment is located at operating floor level for centralization of control and operating convenience. Note flexible coal-handling system; silos form end wall of building

31,250-kw Unit at Williamsburg

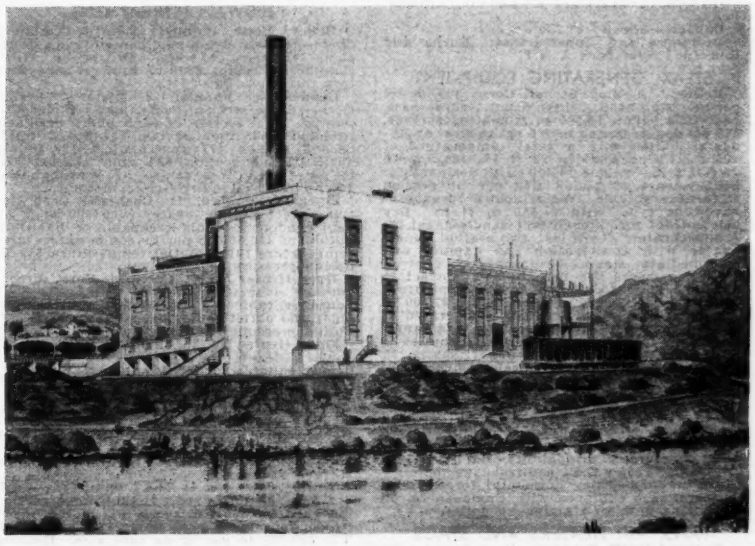

Fig. 2. Architect's perspective drawing of Williamsburg Station with extension added at right. Tall stack is for existing boilers; stack for new boiler projects just above roof

erators to do the right thing at the right time. Automatic controls have been provided as required to assist in performing routine repetitive operations and all operations can be transferred quickly from automatic to manual control or the reverse.

On the main operating floor level, as shown in Fig. 1, are found the boiler control panel, the pulverized coal burners, the forced and induced draft fans, the main turbine generator unit and turbine control board and the switch gear for the new unit's auxiliaries. Electrical connections have been made with the existing station bus system for operation of the station auxiliaries and also from the 13,000-v generator leads and the new generator is connected direct to a new 46,000-v outgoing transformer station outside the plant.

The outstanding features of the new installation are well shown in Fig. 1 and the details of the equipment are given in the List of Equipment, pages 72 and 73.

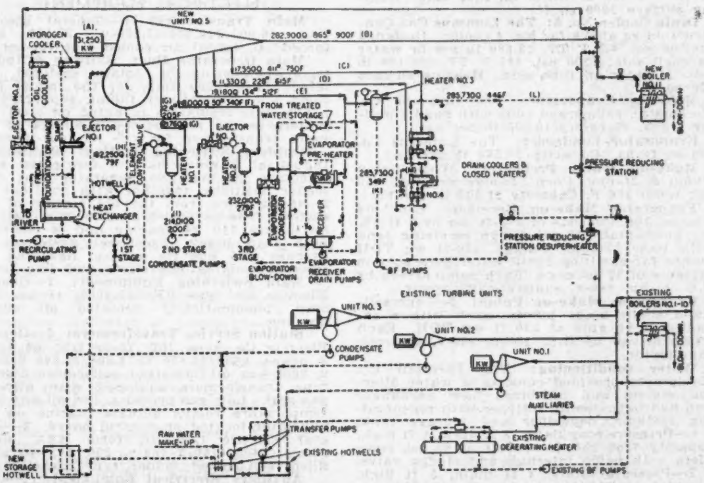

Fig. 3. Heat Balance diagram of 31,250-kw extension showing steam and feedwater tie lines to existing equipment. Tabulation below gives extraction conditions for various loads

Table of Extraction and Feedwater Flows, Pressures and Temperatures, New 31,250-kw Unit

Turbine No. 5 Q = Flow, lb per hr. # = psi absolute

A-Load kw	B (Steam to Turbine)	C (No. 5)	D (No. 4)	E (No. 3)	F (No. 2)	G (No. 1)
31,250	282,800Q	17,550Q	11,330Q	19,180Q	18,000Q	21,760Q
	865# 900F	411# 750F	228# 615F	134# 512F	50# 340F	12.4# 205F
25,000	223,540Q	13,740Q	8,140Q	14,660Q	13,640Q	15,250Q
	865# 900F	319# 710F	177# 590F	103# 485F	38# 320F	10# 193F
18,750	166,040Q	9,630Q	6,460Q	10,150Q	9,730Q	9,670Q
	865# 900F	237# 675F	132# 560F	78# 460F	29# 295F	7.6# 180F
12,500	111,540Q	5,100Q	3,920Q	7,090Q	5,950Q	4,880Q
	865# 900F	158# 645F	88# 530F	53# 435F	20# 280F	5.2# 164F
6,250	59,540Q	2,550Q	1,600Q	3,090Q	2,920Q	940Q
	865# 900F	90# 612F	51# 505F	31# 415F	11.5# 262F	3.0# 142F

A-Load kw	H	I	J	K	L	M
31,250	192,250Q	214,010Q	232,010Q	285,730Q	285,730Q	
	79F	200F	279F	349F	446F	389F
25,000	156,330Q	171,580Q	185,220Q	226,240Q	226,240Q	
	79F	188F	264F	330F	426F	367F
18,750	119,190Q	128,860Q	141,930Q	168,170Q	168,170Q	
	79F	175F	246F	309F	399F	349F
12,500	83,950Q	88,830Q	94,780Q	113,110Q	113,110Q	
	79F	159F	225F	284F	365F	320F
6,250	48,300Q	49,220Q	52,160Q	60,600Q	60,600Q	
	79F	136F	196F	250F	323F	279F

Coal-Handling System

The first outstanding feature is the simple compact coal handling and preparation system. An elevated railroad siding 224 ft long was built at the South end of the plant. Coal cars can be dumped here or directly into the receiving hopper shown at the right of Fig. 1. Coal dumped below the siding is transported by a bulldozer to a storage pile, the storage area being sufficient to store 30,000 tons. The bulldozer packs and rolls the coal into this storage pile in the manner now widely used for such storage. To reclaim coal from the storage pile, the bulldozer transports it to the receiving hopper, Fig. 1.

From the receiving hopper, coal is delivered by an apron conveyor to a belt conveyor, which in turn delivers it to a magnetic separator and crusher, from which it discharges to a Peck carrier. This carrier delivers it to any one of the three concrete silos, Fig. 1, from which it discharges through a coal scale in front of each silo. Each coal scale discharges its coal to the feeder of one the three unit pulverizers set on the lower basement level as shown.

The concrete silos form the end wall of the boiler house. The silos have a capacity of 1500 tons of coal. The conveyor and chute arrangement makes it possible to transfer coal from one silo to another and to load the silos in any manner desired.

The new Williamsburg unit is de-

Principal Equipment in Williamsburg Station Extension

GENERAL

Location: Williamsburg, Penna.
Type of Plant: Central Station
Owners: Pennsylvani Edison Co., Altoona, Penna.
Capacity Added: 31,250 kw
Designers and Constructors: Burns and Roe, Inc., New York 7, N.Y.

STEAM GENERATING EQUIPMENT

Boiler: 1—Riley Stoker Corp. 300,000-lb. per-hr high-head, three-drum, three-pass, bent-tube boiler, 11,000 sq ft heating surface, 975 psi design pressure, 880 psi gage at superheater outlet with a total temperature of 900 F. Furnace width 22 ft 9¾ ins., depth 20 ft-4⅛ in., volume 16,600 cu ft, designed for heat release of 21,.00 Btu per hr per cu ft furnace volume. Water cooled furnace of bare-tube type, with 11,550 sq ft hs. Dry ash bottom for intermittent ash removal.

Superheater: 1—Riley, two-section superheater with combination gas damper and intermediate steam desuperheater control. Design pressure 975 psi. Unit is convertion type designed for 900 F total temperature over range of 300,000 lb per hr to 137,500 lb per hr steam output but can be operated at 825 F total temperature over this load range. Operating pressure at superheater outlet is 880 psi gage. Total heat. surf. 12,900 sq ft.

Economizer: 1—Riley, steel-tube, continuous-element, counterflow economizer with 6500 sq ft hs designed for 1360 psi w.p.

Pulverizers: 3—Riley Atrita unit pulverizers of attrition type designed for a capacity of 11,000 lb per hr each when handling Pennsylvania bituminous coal with 8 per cent total moisture, 55 grindability. Each is driven by 125-hp, 2200-v G.E., squirrel-cage motor.

Burners: 6—Riley horizontal forced draft burners, each equipped with Engineer Co. oil atomizing unit for starting up purposes.

FANS, AIR HEATERS AND STACK

Induced Draft Fans: 2—Prat-Daniel twin fans, each driven by a 350-hp, 2200-v, G.E., squirrel-cage motor through American Blower Corp. hydraulic couplings.

Forced Draft Fans: 2—Green Fuel Economizer Co. double-inlet, constant-speed, forced draft fans, each driven by 150-hp, 2200-v, G.E., squirrel-cage motor.

Oil Coolers for Hydraulic Couplings: 2—Ross Heater and Mfg. Co., channel-type, horizontal oil coolers.

Fly Ash Collectors: Buell Engineering Co. Van Tongeren system including dust hoppers and gas outlet plenum chambers.

Air Heaters: 2—Riley tubular air heaters, counter-flow arrangement, with 17,300 sq ft hs for high temperature heater and 36,300 sq ft hs for the low temperature heater.

Stack: 1—Prat-Daniel Thermix type stack.

BOILER CONTROL AND ACCESSORIES

Combustion Control: Bailey Meter Co. complete combustion system specially designed to include automatic regulation of fuel and air.

Feedwater Control: Bailey Meter Co. three-element control.

Superheater Steam Temperature Control: The Swartwout Co.

Soot Blowers: Diamond Power Specialty Corp.

Soot Blower Pressure Reducing Station: The Swartwout Co., reducing station is air operated and designed to provide steam at 600 psi gage for soot blowers.

Water Columns: 2—Diamond Power Specialty Corp., flat-glass, bi-color reflecting.

Safety Valves: Consolidated.

Power Control Valve: Consolidated.

COAL AND ASH HANDLING

Coal Handling Equipment: Link Belt Co. Consists of track hopper and reciprocating feeder, belt conveyor, crusher, magnetic separator, Peck carrier, reclaiming hopper and apron feeder. Handling capacity 125 tons per hr from track hopper, 50 tons per hr from reclaiming hopper.

Ash Handling Equipment: Allen-Sherman-Hoff Co. For dust removal a hydrovactor vacuum system is provided. Hydraulic ash removal is supplied for furnace of boiler consisting of hopper, sluice-way, hydroseal ash pump with G.E. 75-hp, 440-v, squirrel-cage motor drive. A storage tank (dehydrating), and bilge pump with Century, 7.5-hp, 440-v, squirrel-cage motor drive.

TURBINE-GENERATOR UNIT

Generating Unit: Westinghouse Elec. and Mfg. Co., 35,714-kva, 0.70-pf, 3600-rpm, 3-phase, 60-cycle, 13,800-v, hydrogen-cooled alternator with direct connected 145-kw, 250-v main exciter and 2.5-kw, 250-v pilot exciter. Turbine extracting-condensing, single cylinder, impulse-reaction type designed for 850 psi gage, 900 F TT steam at the throttle and condensing at 29 in. Hg vac. Five bleed points.

Surface Condenser for Turbine-Generator: Allis-Chalmers Mfg. Co., two-pass condenser, 24,000 sq ft condensing surface, ⅝-in. od, 18-BWG, Munts metal tubes, spring supported. Condenser provided with 6750-gal storage hotwell separately supported; three-stage, 3-element, Croll-Reynolds steam jet evacuator, and 1000-sq ft internal air cooler. For initial start-up, a Croll-Reynolds hogging jet is included.

PUMPS, HEATERS AND FEEDWATER TREATMENT

Boiler Feed Pumps: 2—Allis-Chalmers double-suction, five-stage, centrifugal pumps, each 745 gpm capacity. Driven by Allis-Chalmers 700-hp, 2200-v, squirrel-cage motors.

Condensate Pumps: 3—Foster Wheeler Corp., three-section centrifugal condensate pumps. First section of each pump designed to handle 436 gpm against 132 ft wg TDH. Second section 477 gpm against 129 ft wg TDH. Third section 537 gpm against 312 ft wg TDH. Unit driven by Westinghouse 125-hp, 2200-v, squirrel-cage motor.

Open Heater No. 1: Cochrane Corp. jet type direct contact heater with 200 sq ft hs vent condenser. Unit is capable of handling output of 480,500 lb per hr condensate. Inlet temperature 101 F, outlet temperature 189 F, design pressure 30 psi.

Open Heater No. 2: Cochrane Corp. direct-contact deaerating heater with vent condenser suitable for 528,400 lb per hr output. Inlet and outlet temperatures 189 and 263 F, design pressure 52 psi.

Open Heater No. 3: Cochrane Corp. direct-contact deaerating heater with vent condenser suitable for 569,300 lb per hr contact. Inlet and outlet temperatures 269 and 327 F, design pressure 125 psi.

Closed Heater No. 4: The Lummus Co. Heaters are channel-type, U-tube construction designed for 300 psi, 690 F TT, 14,000 lb per hr steam on shell side; 1200 psi, 400 F TT, 320,100 lb per hr water on tube side. Heating surface 956 sq ft.

Drain Cooler No. 4: The Lummus Co. Coolers are channel-type, U-tube construction designed for 300 psi, 400 F TT, 37,900 lb per hr condensate on shell side; 1200 psi, 400 F TT, 320,100 lb per hr on tube side. Heating surface 252 sq ft.

Closed Heater No. 5: The Lummus Co. Construction as above for No. 4 heater. Designed for 500 psi, 800 F TT, 23,800 lb per hr steam on shell side; 1200 psi, 500 F TT, 320,100 lb per hr water on tube side. Heating surface 2090 sq ft.

Drain Cooler No. 5: The Lummus Co. Construction as above for No. 4 cooler. Designed for 500 psi, 475 F TT, 23,800 lb per hr water on shell side; 1200 psi, 425 F TT, 320,100 lb per hr water on tube side. Heating surface 190 sq ft.

Make-up Evaporator: The Lummus Co. Horizontal, submerged coils with bundle pulling track. Capacity 10,000 lb per hr.

Evaporator Condenser: The Lummus Co. 910 sq ft hs. Capacity 20,560 lb per hr.

Make-up Water Preheater: Worthington Pump & Machy. Corp. Design pressure 150 psi, temp 366 F. Capacity 21,500 lb per hr.

Evaporator Make-up Receiver: Economy Pumps, Inc. Consists of 3½-ft dia by 7 ft 5¾ in., horizontal, 150-psi design receiving tank with two 125-gpm, 4-stage, 230-ft wg TDH pumps for handling 326-F water with suction pressure of 83 psi gage. Each pump driven by G.E. 15-hp, 440-v, squirrel-cage motor.

Evaporator Make-up Pump: 2—Ingersoll-Rand single stage pumps, each with a capacity of 50 gpm at 230 ft wg TDH. Each pump driven by G.E. 10-hp, 440-v, squirrel-cage motor.

Water conditioning: The Permutit Co. Equipment provided consists of water filtering system and combined base exchanger and hydrogen-zeolite softener with regenerating systems, degasifier and storage tank.

1—Pressure coagulator, 8 ft diam, 9 ft high, capacity 3300 gal, to operate at 65 psi, complete with baffle internals and sludge valve.

2—Pressure filters, 4 ft diam, 5 ft high, complete with filtering medium, deflector plate, backwash and rinse rate controllers. Capacity each unit 25 gpm.

2—Softeners, one sodium zeolite, one hydrogen zeolite. Total combined alkalinity 15 ppm. Capacity, two units, 64,000 gal per day with flow rate of 45 gpm.

Sodium zeolite unit, 3 ft diam, 7 ft high, equipped with regenerating brine tank 3 ft diam, 4 ft high. Capacity 32,000 gal per regeneration.

Hydrogen zeolite unit, 3 ft diam, 7 ft high, equipped with regenerating equipment consisting 14-gal dilute acid tank 2 ft diam, 2½ ft high. Capacity 19,200 gal per regeneration.

1—Degasifier, 2 ft diam, 16-ft high, complete with float control valve and 200-cfm blower.

1—Storage tank, 13 ft diam, 10 ft high. Capacity 3100 gal.

1—Phosphate feeder for installation in discharge line of evaporator make-up pump.

Motor Operated Steam and Feed Water Valves: Chapman Valve Mfg. Co.

Station Piping: Pittsburgh Piping and Equipment Co.

MISCELLANEOUS PUMPS

1—Ingersoll-Rand 25,000-gpm spray pond pump; single-stage, bottom-suction, horizontal, centrifugal pump with G.E. 600-hp, 2200-v, squirrel-cage motor.

1—A. W. Cash Co. type 90, 3-gpm, oil-operated damper regulator pump, with Master Electric, 1/3-hp, 440-v, squirrel-cage motor.

1—Goulds Pumps, Inc., 660-gpm condensate recirculating pump; single-stage, double-suction, centrifugal pump with Louis Allis 20-hp, 440-v, squirrel-cage motor.

1—Goulds Pumps, Inc, 1100-gpm sluice water pump; single-stage, double-suction, centrifugal pump with Louis Allis 125-hp, 2200-v, squirrel-cage motor.

2—Goulds Pumps, Inc., 500-gpm service water pumps; single-stage, double-suction centrifugal pump with Louis Allis 25-hp, 440-v, squirrel-cage motors.

1—Goulds Pumps, Inc., 50-gpm start and fill pump; single-stage, centrifugal pump with Louis Allis 5-hp, 440-v, squirrel-cage motor.

1—Goulds Pumps, Inc., 150-gpm sump pump, vertical type, with 3-hp motor.

1—Goulds Pumps, Inc., 200-gpm condenser wash pump; double-stage centrifugal pump with Louis Allis 75-hp, 440-v motor.

2—Pomona Pump Co. 150-gpm cooling water pumps; submerged-runner type pump with Westinghouse 5-hp, 440-v, squirrel-cage motors.

1—Pomona Pump Co. 1000-gpm sump pump; vertical submerged-runner type pump with United States 20-hp, 440-v, squirrel-cage motor.

2—Allis-Chalmers Mfg. Co. 11,250-gpm single-stage, centrifugal condenser circulating water pumps with Allis-Chalmers 100-hp, 2200-v, squirrel-cage motors.

2—Engineer Co. 8-gpm, spiral-gear, rotary, fuel oil pumps with G.E. 2-hp, 440-v motors.

1—Allen-Sherman-Hoff Co, 30-gpm, oil-operated ash gate pump. Positive displacement rotary type with G.E. 5-hp, 440-v, squirrel-cage motor.

SCREEN HOUSE

Water Intake Screen: 1—Chain-Belt Co. vertical traveling refuse screen for water intake 25,000-gm capacity, driven by G.E. 3-hp, 440-v, squirrel-cage motor. Screen equipped with Peerless 170-gpm wash pump driven by G.E. 15-hp, 440-v, squirrel-cage motor.

ELECTRICAL EQUIPMENT

Main Transformer: 1—General Electric Co.: 46,000/110,000-13,800-v, 37,500 kva, forced oil, forced air cooled transformer.

Main Generator Bus: Railway & Industrial Engineering Co., totally enclosed, isolated phase, 2000 amp, for the indoor portion; 3 in. IPS copper tubing supported on heavy duty insulators mounted on steel box girders to the low tension bushings of the main transformer for the outdoor portion.

Outdoor Switching Station: Railway & Industrial Engineering Co. fabricated steel structure having two generator and four feeder positions, together with positions for 2—45 kv lines from the old section of the station. The switching station was designed for future 110 kv spacing and is complete with load break disconnect switches, for by-pass and bus tie service, lightning arresters, coupling capacitors and line traps.

Main Switching Equipment: 1—General Electric Co. type FK-339-1000, 46 kv, 1200 amp, pneumatically operated oil circuit breaker.

Station Service Transformers: 2—General Electric Co. type HT, form DM, 60 cycle, 3 phase, 6600/11,430-Y/13,200/22,860-Y-2200-v, 3000 kva, oil immersed, self-cooled outdoor type transformers equipped with nitrogen gas seal. Low gas pressure, low oil and high temperature relays actuate alarms on annunciator located on control board. 3—General Electric type H, form KSA, single phase, 2400/4160-Y-480-v, 200 kva pyranol-filled, self-cooled indoor type transformers.

Auxiliary Electrical Equipment: 1—General Electric Co. type FK-339-500, 23 kv, 600 amp TPST, electrically operated oil circuit breaker controlling power to 1—3000 kva station service transformer. 2—Westinghouse type B-28-B, 1200 amp, 15 kv TPST, metal enclosed oil circuit breakers connected to 6600-v generator buses and controlling power to 1—3000 kva station service transformer.

Auxiliary Switchgear: Westinghouse Elec. & Mfg. Co. type 50-DH-50, 1200 and 600 amp, 5000-v air circuit breakers, drawout type, electrically operated, in metal enclosed structures. Westinghouse Elec. & Mfg. Co. type DA-50 and DK-25 drawout type, 600-v air circuit breakers, electrically and manually operated, respectively, in metal enclosed structures.

Station Control Board: Westinghouse Elec. & Mfg. Co. duplex cubicle type in three sections. The generator cubicle has mounted on its front panel all indicating meters, control switches and lamps, pilot exciter rheostat and voltage regulator controls associated with the control of the 31,250-kw generator and 37,500-kva transformer. The rear panel has mounted thereon the generator voltage regulator, generator-transformer differential and auxiliary relays. The control cubicle for station buses has mounted on its front panel the indicating meters, control switches and lamps associated with the control of power to 2300-v and 460-v station auxiliary buses and on the rear panel of

this cubicle are mounted the station service transformer overload and differential relays and station watthourmeters. Another station control cubicle has mounted on its front panel station load indicator-transmitter, station auxiliary bus voltmeters and annunciator. On the rear panel of this control cubicle are located the potential and auxiliary relays for automatic transfer of auxiliary load.

440-v Auxiliary Power Cabinets: Lexington Electric Products Co., with Westinghouse Elec. & Mfg. Co. type AB air circuit breakers.

Station Lighting: Lexington Electric Products Co. lighting panels. Lighting Fixtures: Holophane prismatic glass, Hibay and Lobay reflectors used throughout the new addition, except around boiler walkways and stairways where Crouse-Hinds guard type fixtures were used. Vaportight fixtures used throughout the coal handling area. Holophane outdoor type substation fixtures used in the outdoor auxiliary substation.

Load Indicator: Westinghouse Elec. & Mfg. Co.; Turbine Room instrument—dual face and Boiler Room instrument flush mounted on boiler panel.

Power and Control Cable: Kerite Insulated Wire & Cable Co., The Okonite Co.

Communication System: Bell Telephone Co. of Pennsylvania.

Carrier Current Relaying and Communication: General Electric Co.

MISCELLANEOUS EQUIPMENT

Blower: Roots Connerville Co.
Bulkhead Doors: J. W. Fiske Iron Works.
Caulking Lead & Jute: Belmont Smelting and Refining Works, Inc.
Coal Scales: Richardson Scale Co.
Combustion Control Compressor: American Air Compressor Corp.
Concrete Pipe: Concrete Porospipe Corp.
Condensate Cooler: Alco Products Co.
Condensate Heater Drainer Control: Bailey Meter Co.
Conductivity Recorders: Leeds & Northrup Co.
Expansion Joints: Alpha Steam Spec. Co., Howard Iron Works.
Fire Brick: General Refractories Co.
Fuel Oil Pumping System: The Engineer Co.
Gages: Crane Co., Ernst Water Column & Gage Co.
Heater No. 3 Condensate Control (3-element control): Bailey Meter Co.
Hoists: Yale & Towne Mfg. Co.
Industrial Thermometers: C. J. Tagliabue Mfg. Co.
Kalamein Doors: Philadelphia Fire Retardant Co., Inc.
Liquid Level Controllers: Fisher Governor Co.; Hanlon-Waters, Inc.
Oil Purification System: DeLaval Steam Turbine Co.
Pipe Insulation: Ehret Magnesia & Mfg. Co.
Piping: Pittsburgh Piping & Equipment Co.
Pressure Gages: Manning, Maxwell & Moore, Inc.
Pressure Reducing & Desuperheater Station: Hagan Corp.
Reinforcing Steel: Truscon Steel Co.
Roof Ventilators: H. H. Robertson Co.
Rubber Expansion Joints: U. S. Rubber Co.
Spray Pond System: Marley Co.
Station Air Compressor: Sullivan Machinery Co.
Steam Jet Syphons & Primer: Schutte & Koerting Co.
Steel Gratings: Borden Metal Products Co.
Steel Rolling Door: Kinnear Mfg. Co.
Steel Sheet Piling: Weirton Steel Co.
Strainers: Elliott Co.
Straub Degassing Condenser: W. H. & L. D. Betz.
Tanks: Buffalo Tank Corp.
Valves: Atwood & Morrill Co., Chapman Valve & Mfg. Co., Fisher Governor Co., Golden Anderson Valve Spec. Co., Ludlow Valve Mfg. Co., Manning, Maxwell & Moore, Inc., Stock Engineering Co.
Window Sashes: Michael Flynn Mfg. Co.

CONTRACTORS

Concrete Coal Silos: W. C. Neill
Concrete Foundation Piers: Spencer, White & Prentis, Inc.
Ducts, Breeching & Coal Chutes: Connery Constr. Co.
Electrical: Hatzel & Buehler, Inc.
Excavation: Burns and Roe, Inc., Agents for Penna. Edison Co.
Foundations: Wilson Constr. Co., Inc.
Insulation: Chas. S. Wood
Metal Siding: American Steel Band Co.
Piping: Pittsburgh Piping & Equipment Co.
Roofing: H. C. Smith Co.
Roof Slabs: Lastik Products Co.
Structural Steel: Lehigh Structural Steel Co.
Superstructure: Wilson Constr. Co.

signed to burn bituminous coal from Cambria County but during the present war emergency will burn coal from any available source.

Fuel Burning Equipment and Gas Loop

The three attrition type pulverizers installed for this unit are of 11,000-lb-per-hr capacity each when pulverizing coal of 8 per cent total moisture, 55 grindability. Six horizontal pulverized coal burners are fed by these pulverizers, Figs. 1 and 4, which are cross-piped to the burners. Each pulverizer feeds two horizontal coal burners which are so arranged that correct flame distribution can be obtained in the furnace and the number of pulverizers in service can be varied depending on the load.

The steam-generating unit and furnace are shown in detail in Fig. 4. The furnace has a volume of 16,600 cu ft and is of completely water-cooled construction with bare tubes having 11,550 sq ft heating surface and a dry bottom for intermittent ash removal. The furnace is designed for a heat release of 21,200 Btu per cu ft per hr at normal load on the steam generating unit.

Combustion gases from this furnace pass through the steam generating and superheater section, then downward through the upper high temperature air preheater section, through the economizer and continue down through the lower air preheater section.

The vertical, tubular type air preheater is constructed as shown in two sections, to reduce the length of the tubes to practicable proportions and facilitate cleaning and to obtain maximum heat recovery without resort to a steaming economizer.

At the bottom of the lower air preheater, the combustion gases make a 90 deg turn, a fly-ash hopper being provided to collect fly-ash dropped out at this point. The gases then pass to the dust collectors through which they are drawn by the induced draft fans, which discharge them to the stack. Fly-ash is discharged from the fly-ash hoppers and the dust collectors by a hydrovactor system, which delivers it to the dehydrating ash storage tank. Ash from the furnace

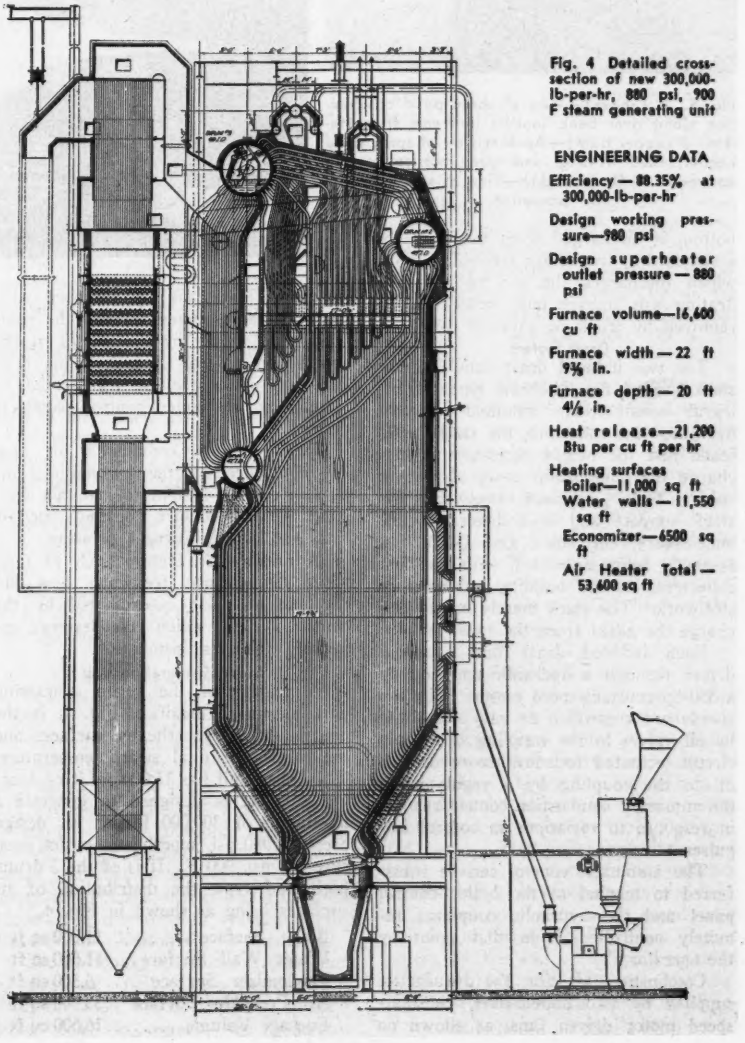

Fig. 4 Detailed cross-section of new 300,000-lb-per-hr, 880 psi, 900 F steam generating unit

ENGINEERING DATA

Efficiency — 88.35% at 300,000-lb-per-hr

Design working pressure—980 psi

Design superheater outlet pressure — 880 psi

Furnace volume—16,600 cu ft

Furnace width — 22 ft 9⅜ in.

Furnace depth — 20 ft 4⅛ in.

Heat release—21,200 Btu per cu ft per hr

Heating surfaces
Boiler—11,000 sq ft
Water walls — 11,550 sq ft
Economizer—6500 sq ft
Air Heater Total — 53,600 sq ft

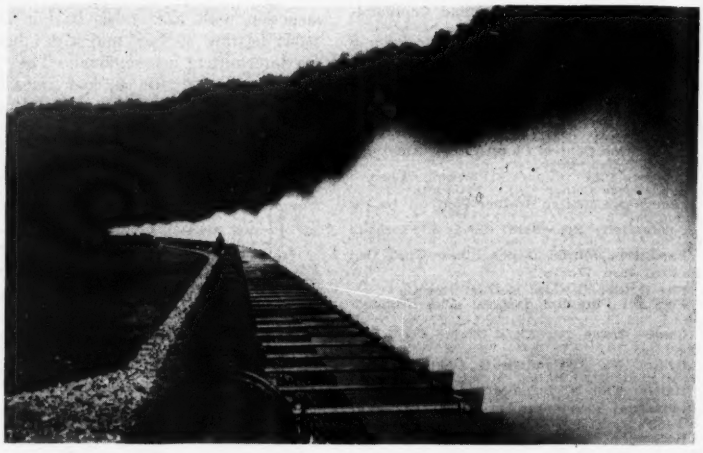

Fig. 5. A (above)—View of spray pond construction along river bank, looking upstream from station. B (upper right)—Another view of spray pond header, 1000 ft long, and spray nozzles, looking upstream. C (lower right)—View of spray pond in operation

bottom is discharged from the plant by a standard hydraulic ash removal system, which discharges the ash to a dehydrating ash storage tank, whence it is removed by truck or railroad car.

Draft System

The two induced draft fans and the stack are of the Thermix type, of integral construction, mounted directly over the dust collectors, the stack being made just the height necessary to discharge the combustion gases above the roof. Thus, overhead steelwork for stack support and long breeching are unnecessary, the stack and I. D. fan assembly being supported, with the dust collectors, on the building substructure steelwork. The stack merely has to discharge the gases from the fans.

Each induced draft fan is motor driven through a hydraulic coupling by a 350-hp constant-speed motor. The fan speeds are controlled to vary the draft by oil valves in the coupling oil supply circuit, actuated to admit more or less oil to the coupling by a regulator of the automatic combustion control system, in response to variations in control impulses.

The automatic control can be transferred to manual at the boiler control panel and the hydraulic couplings remotely controlled from that point by the operator.

Combustion air for the furnace is supplied by two double-inlet, constant-speed motor driven fans, as shown on Fig. 1. These fans are equipped with vane control, actuated to vary the combustion air supply by a regulator of the combustion control system. This control can, of course, be transferred to manual at the boiler control panel, if desired.

Fuel feed and combustion air flow are controlled by the automatic combustion control system to maintain constant steam pressure, desired fuel-air ratio and correct furnace pressure.

A number of factors such as total steam temperature, feedwater flow and the like are also co-ordinated by the control system, which was designed especially for this installation.

Steam Generating Unit

A feature of the steam generating unit, shown in detail in Fig. 4, is the distribution of superheater surfaces and the control of total steam temperature. The boiler unit has 11,000 sq ft of heating surface, is designed to generate a maximum of 300,000 lb per hr, design pressure 980 psi, superheater outlet pressure 880 psi, 900 F. It is of the 3-drum, high-head type, the distribution of its surfaces being as shown in Fig. 4.

Boiler Surface	11,000 sq ft
Water Wall Surface	11,500 sq ft
Economizer Surface	6,500 sq ft
Air Preheater Surface	53,600 sq ft
Furnace Volume	16,600 cu ft

At maximum output the unit is designed for an efficiency of 88.35 per cent.

The superheater is of the convection type with a total heating surface of 12,900 sq ft located between first and second boiler tube banks as shown. It is in two sections; steam flowing from the rear section through an intermediate steam header, then to the high temperature superheater and to the desuperheater in the front drum of the boiler, thence to the front superheater section and thence to the turbine. In addition to the desuperheater, dampers at the entrance to the third boiler pass are provided to control the flow of furnace gases over the rear superheater section.

These superheat control dampers are manually adjustable by means of a mechanical linkage, operated by a handwheel and gear located on the main operating floor at the right and left hand corners of the boiler and within a few steps of the boiler control panel. The intermediate steam desuperheater in the boiler drum is automatically controlled from the steam temperature by a special temperature control. The superheater is designed to maintain 900 F total steam temperature over a range of 300,000 to 137,000 lb per hr output. By means of the damper and desuperheater controls together, the total steam tem-

perature can be maintained at 825 F over the same range.

Turbine-Generator Unit

The new 31,250-kw turbine generator is remarkably smooth and free from vibration when in operation and this is one of its principal characteristics. The unit is set on the main operating floor as in Fig. 1, with the turbine control panel conveniently located against the building steelwork a few feet from the steam end of the turbine.

Another interesting feature of the new unit is that when standing between it and the adjacent existing 8000-kw unit the observer sees that the new unit, with 4 times the capacity, is no longer than the old 8000-kw unit except for the exciter, and the 8000-kw unit has a separate exciter. This is a splendid illustration of the progress in turbine design in recent years towards compactness, due partly to the successful development of 3600-rpm machines, partly to hydrogen cooling and partly to vast improvement in internal details of both turbines and generators.

The entire appearance of the foregoing boiler and turbine assembly is open, clean and simple, with controls and major equipment all within easy reach, plenty of room around all major equipment for operation and servicing, nothing crowded into small space. There is, of course, no partition between the new boiler and turbine, the entire end wall of the station parallel to the section Fig. 1 is mostly windows and the entire room is clean, airy and a very attractive place in which to work.

The connections of the equipment are shown diagrammatically in Fig. 3 and need no further explanation. The auxiliary equipment itself is all below the operating floor level and here, too, the layout is open and convenient, with plenty of room to get at everything. On these lower levels are condenser and auxiliaries, feed pumps, heaters and the other equipment detailed in the List of Equipment, pages 72 and 73.

Three features here are especially noteworthy. One is the way in which jet type direct-contact heaters are employed as the Nos. 1, 2 and 3 feedwater heaters, the condensate pumps being of the three-section type consisting of one pump rotor, with three separate pump stages pumping at different heads from condenser hotwell and each of the first two open heaters respectively. This idea is not new, of course, for it has been used successfully for years at the South Amboy and Bremo Stations designed by the same designer.

River Forms Spray Pond

A second feature of interest is the spray pond shown in Fig. 5. The condenser circulating water is drawn from upstream of a low dam across the Juniata River about 200 yards upstream from the station. Normally it is discharged from the condenser below the dam to prevent recirculation. However, there are certain periods of low water in this river, hence a method was provided to recirculate the condenser water to a point above the dam, cool it by spraying into the river and return it to the condenser.

Instead of building a spray pond, it seemed logical to use the river itself. Accordingly, a rip-rap wall was built along the river bank upstream from the dam, a section of pipe ranging from 30 in. to 12 in. in diameter was run about 1000 ft upstream, see Fig. 5, A and B, spray nozzles were installed on pipes projecting from the main header out over the river and the spray pond operates as shown in Fig 5C. When it is in use, a 25,000-gpm spray pond pump, driven by a 600 hp motor, circulates the water to the spray nozzles.

Flood Protection

The Juniata River can on occasion overflow its banks. These fluctuations are, of course, characteristic of many rivers. In 1936 a flood occurred on the Juniata that did much damage and caused many interruptions of work in all industries on its banks. Hence, in designing the new Williamsburg extension, precautions were taken against such a flood in the future. The entire basement wall of the building for the extension, up to a level about 6 ft above the high water mark of 1936, is of flood proof construction. Special concrete walls designed to resist the water pressure are employed and all openings between old and new stations below the high water mark can be closed by water-tight doors. Thus the basement of the extension cannot be flooded.

When constructing foundations for the new extension, provision was made for foundation drainage by suitable sump and drainage pumps. The discharge from these pumps, which is always at a low temperature, is used as cooling water in the heat exchanger ahead of steam jet air ejector No. 1, hydrogen cooler and turbine oil cooler, as shown on Fig. 3.

Make-up water for the new unit is treated by a water filtering system, combined base exchanger and hydrogen-zeolite softener system with regenerating systems, degasifier and storage tank, as described in detail in the List of Equipment.

All auxiliaries in this extension are motor-driven, by 2200-v or 440-v squirrel-cage motors.

Electrical Connections

The generator produces power at 13,800 v, 3 phase, 60 cycles, which is transmitted over an isolated phase, totally enclosed indoor bus, through wall bushings to an outdoor bus to the low voltage bushings of a 37,500-kva forced-oil, forced-air-cooled, outdoor type transformer. The generator and its associated transformer operate as a unit, the generator voltage being stepped up to 46 kv, the transmission voltage of the Pennsylvania Edison Co. in this area.

The switching operation is, therefore, as simple as possible; only one pneumatically-operated 46-kv oil circuit breaker being used to connect the generator transformer unit to the outdoor 46-kv main bus. The new outdoor switching station has been designed for future conversion to 110 kv but for the present, the existing 46-kv indoor buses have been extended to the outdoor switching station. Two existing transmission lines and new transmission line carry the output of the Williamsburg Station to Altoona and Warrior Ridge.

The new Warrior Ridge transmission line is a wood-pole H structure designed for future operation at 110 kv and will become a part of the 110 kv ring of the Pennsylvania Edison Co. system. This line is protected by carrier-current high speed relaying and carrier-current communication.

Station Auxiliary Power

Station auxiliary power for the new addition is taken from a tap off the 13.8-kv generator bus through an oil circuit breaker to one of the 3000-kva step-down transformers, which in turn supplies the two 2300-v station auxiliary buses. The other source of supply for station auxiliaries is from the two 6600-v station buses in the old section of the station, through new metal enclosed oil circuit breakers to the other 3000-kva station service transformer, which in turn is connected to the two 2300-v station auxiliary buses. The normal source of power is from the new generator but in case of power failure or low voltage, the 13,800-v and 2300-v breakers are tripped and the 6600 and 2300-v breakers controlling the other 3000 kva station service transformer are closed. The 440-v station auxiliary bus for the new addition is supplied by means of a 600-kva transformer fed from one of the 2300-v station buses and is also connected to the existing 440-v bus in the old station.

Thus, by means of interlocking, continuity of service is maintained on all the station buses. The control of the station buses is under the supervision of the main switchboard operator and the above switching can be manual, but normally the control is set up for automatic operation. During storms it is the practice to isolate the smallest generator in the older section of the station, placing all the auxiliary station load on this generator.

Auxiliary Controls

Dual control of all major station auxiliaries permits starting and stopping any auxiliary from either of the boiler or turbine control boards or locally at the auxiliary. Control switches, indicating lamps and ammeters, together with alarms, are mounted on the boiler control panel. The boiler auxiliaries are motor driven, hence the boiler sequence interlocking is incorporated in the electrical control system and coordinated with the air actuated combustion control system by the use of solenoid-operated valves and pressure switches. The turbine control board is of cubicle construc-

(*Continued on page* 148)

Compressed Air Power in Foundry Practice

Many years ago compressed air was made available in foundries for blowing and cleaning purposes, and with advances in foundry practices new uses for compressed air power have been developed. The modern foundry finds this form of power safe, reliable and convenient in such operations as core-box cleaning, core forming, agitating molding machines, hoisting, conveying, sand-blasting, and driving many types of air-powered tools

AMONG THE 100 and more key industries which utilize compressed air as a chief source of power, one of the most prominent is the foundry where a large proportion of normal operations are performed by means of air-operated foundry equipment.

While the air applications may vary somewhat in different types of foundries in accordance with the size and nature of the castings being produced, it is interesting to note how much the average plant of this kind depends upon compressed air for handling operations which are characteristic in any foundry.

In order to get an overall conception of the importance of air power in this field of industry, a survey of its uses was made in one of the nation's largest foundries* producing gray iron castings ranging from a few pounds to over 1000 lb in weight.

In this plant, every department, including the company's maintenance division, uses compressed air to facilitate some phases of work whether it involves the operation of large jolt-roll-over machines or simply blowing excess sand from a core box.

At this big 13-acre factory there are about 2000 line outlets furnishing air power to hundreds of machines and portable tools.

Fig. 1. Six motor-driven air compressor units in the power plant supply compressed air for foundry purposes in the plant of the Ferro Machine & Foundry Co.

Fig. 2. Using blast of air to clean core box

Compressed Air Supply

Air is supplied from the power plant housing 6 compressor units of the motor driven, reciprocating type. The compressors range in size from 152 to 800 hp, with air output from 600 to 3600 cu ft per min.

Generally, 4 compressors are in continuous operation to supply the normal air requirements of about 6000 cu ft of air per min per 8-hr shift, with 2 units available for standby service.

The air is piped through 8 and 10-in. lines to three storage tanks located outside the building where the pressure is maintained at 100 psi, a pressure found most satisfactory for this particular foundry.

Overhead piping, in lines of from 6 to 10 in., all located overhead, carries the compressed air from the tanks throughout the plant.

Core-making and Molding Applications

Among the most prominent uses is in the core-making department where air furnishes the power for operating a large battery of core blowing machines. This operation is shown in Fig. 2 where an air stream is being used to clean the core box, the operation requiring from 4 to 6 cu ft of air per box. The box is then positioned in the core blower, where approximately 5 lb of sand is air-forced at a high velocity into the crevices of the box to form a core for a motor head casting. This machine sand blowing operation consumes only 3 sec.

Molding machines, used in the production of various automotive parts, constitute a vital application of compressed air in this foundry. Among the various types and sizes of pneumatically-operated molding machines are those of the jolt-squeeze design such as shown in Fig. 3. Here, molds for gear housing castings are being produced. Besides jolting and squeezing the sand firmly in the mold, air power is used to vibrate the work and clear air inlets and outlets of any loose sand.

Hoisting with Compressed Air

An air hoist is brought into service for handling the molds and facilitates

*Data and photos for this article were obtained by the Compressed Air Institute from the Ferro Machine & Foundry Co., Cleveland, Ohio, one of the country's leading gray iron foundries.

in turning the flasks during the molding process.

A general view of several of the many air hoists used in the plant for materials handling operations is shown in Fig. 4. Lifting capacities range from 300 to 700 lb with lifting speeds running from 12 to 25 fpm.

An interesting adaptation of one air hoist involves its unusual use in moving large flask molds along a roller conveyor. The hoist is mounted horizontally under the rollers (see Fig. 5). A dog, mounted on the cylinder pistons, contacts the flasks at the end of the line and pushes them a distance of about 10 ft along the conveyor to the point where the mold pouring operation is conducted. On the return stroke of the piston, the dog drops down in the center opening of the split conveyor, passing underneath the flasks until the piston reaches the limit of its stroke when it again raises up to contact the next group of flasks to be moved.

Many kinds and sizes of castings are effectively cleaned by means of air sand-blasting. The castings are arranged on one-half of a turn-table which is then rotated until the castings are positioned inside the metal enclosure. The operator then blasts the work with a stream of air-propelled sand, thoroughly cleaning all casting surfaces. A combination of 75 per cent air and 25 per cent sand is ejected through a 2-in. hose held by the operator who directs the blast stream against the castings. The operation is viewed through a window in the enclosure.

Compressed Air Tools

Characteristic of the many foundry jobs now performed by means of portable air-powered tools are chipping, grinding, core-breaking, drilling and cleaning. Virtually every type of cutting and cleaning wheel is used including wire brushes and specially-shaped buffers and emery wheels. For each job, the speed of the tool is regulated in accordance with an analysis of the specific type of work to be done. Chipping bosses off castings (Fig. 6), typifies the important uses for air-powered tools which dominate throughout the plant. This work constitutes only a very small percentage of the chipping, scaling and scraping operations handled by such tools. Over 150 chipping hammers alone are used by the company for various duties.

Fig. 3. Pneumatically operated molding machine

In the operation of gray iron cupolas, combustion air for uniform melting is supplied by centrifugal blowers. Typical of the blower installations pointed out in the survey was one powered by a 24 hp electric motor delivering 8000 cu ft of air per min at a pressure of 1.25 psi. The blower unit is light in weight and requires a relatively simple foundation to operate with a minimum of vibration.

The convenience of air power is apparent even in the maintenance department which uses a paving breaker for such jobs as breaking up floors for machinery foundations, and jack hammers for knocking out walls, etc.

For specific power purposes, compressed air motors are obtainable in rated horsepowers of from 2½ to 18, under 90 psi air pressure. Both reversible and non-reversible types are made, the reversible motors having a smaller horsepower rating and a somewhat higher consumption of air, but with greater starting power under heavy loads.

Speeds of non-reversible air motors range from 1500 rpm in the smallest sizes to 750 rpm in the largest. Reversible air motors range in speeds of 1200 to 550 rpm.

The survey of the uses for compressed air in this leading foundry illustrates why this type of power is considered all-important among foundry officials throughout the country who credit its efficient application as being extremely important in helping boost castings capacity to approximately 18,000,000 tons annually.

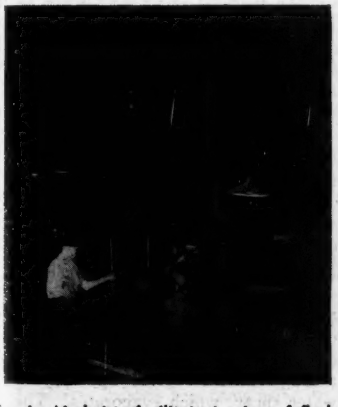

Fig. 4. Air hoists facilitate turning of flasks

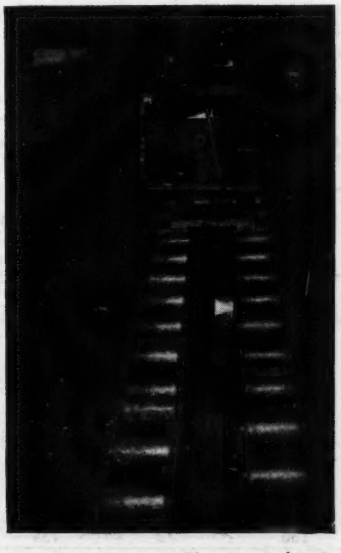

Fig. 5. Air hoist used to convey large flask molds

Fig. 6. Compressed air tool simplifies chipping operation

What the Power Engineer Needs to Know About

Evaporative Cooling

By

M. H. OLSTAD

Chief Engineer
Niagara Blower Co.

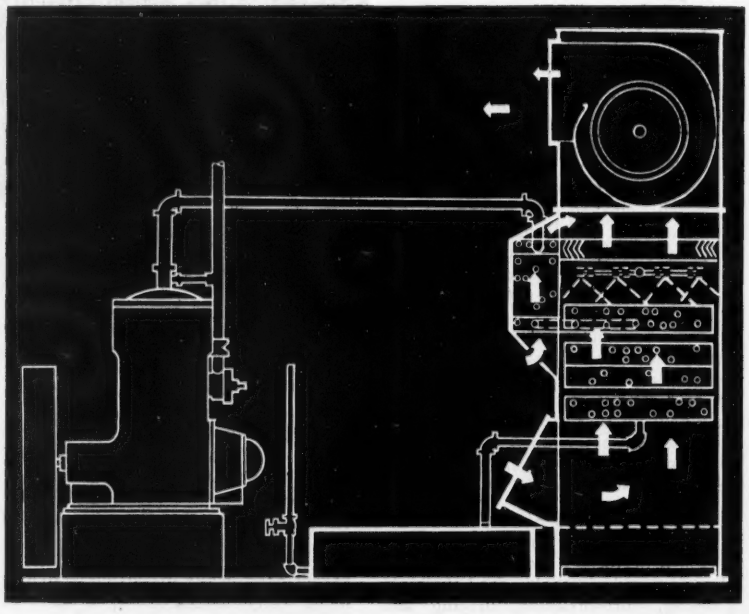

Fig. 1. Diagram of a typical use of the evaporative cooler for condensing in a refrigeration plant

THE PRINCIPLE OF EVAPORATIVE COOLING covers a large field. The evaporative condenser shown in Fig. 1, as used in many refrigeration plants, is only one application of this principle. Evaporative cooling equipment is now widely used to cool gases and liquids, also to condense gases in a range of temperatures from 80 F to 180 F.

Some common applications are:

Evaporative condensers in refrigeration
Diesel or gas engine jacket water
Lubricating oil cooling
Oil and water quenching baths
Hydraulic fluids
Chemical intermediates
Viscosity control
Industrial coolants
Vapor gas condensing
Steam condensers

At fluid temperatures above 180 F, evaporative cooling is not ordinarily used because dry air cooling or condensing equipment may prove more economical in first cost.

At fluid temperatures below 80 F, refrigeration is ordinarily required because the prevailing wet bulb temperatures in summer will not permit cooling below this temperature.

Table I. Rating and dimension tables for typical Evaporative Cooler Units

Model No.	Rating — Tons* at Condensing Temp. Ammonia 95° F	Freon 105° F	Approx. Overall Dimensions In Inches Height	Width	Length
A	17.1	20.0	79	36	75
B	18.9	23.0	77	32	95
C	25.0	29.0	90	32	98
D	30.9	36.0	90	32	98
E	34.2	40.0	90	32	123
F	41.1	48.0	90	32	123
G	51.7	60.0	99	52	134
H	68.4	80.0	126	62	139
I	82.0	96.0	130	72	139

*Ratings are based upon 76° Wet Bulb and 40° Suction Temperature.

What Evaporative Cooling Is

The evaporative cooler combines into one unit of equipment the water cooled exchanger, the cooling tower and the water circulating system.

The principle of evaporative cooling or condensing is to remove the heat from a fluid inside a coil and pass it on to a water spray outside the coil, and then remove the heat in an air stream in the form of water vapor. Thus, for every one pound of water evaporated into the air stream, 1000 Btu are removed from the fluid. This immediately demonstrates the tremendous water saving in this type of equipment. Ordinary shell and tube exchangers utilize only 15 to 20 Btu per lb of water in usual practice.

As shown in Fig. 2, the evaporative cooler consists of three essential parts: the fan section, the coil and spray section, the tank and pump section.

The fan draws air over the sprayed coil. Spray water is collected in the tank under the coil and recirculated by the pump over the coil. The fluid passing through the coil gives up heat to the water spray, which evaporates. The air

The Why and How of evaporative cooling boiled down for war-busy engineers . . . What evaporative coolers are and how they operate . . . Capacities and how they depend on entering wet bulb temperatures and condensing temperatures . . . How install coolers? . . . How operate them? . . . What maintenance do they need? . . . Points to look for in design . . . Applications of evaporative coolers in refrigeration and process

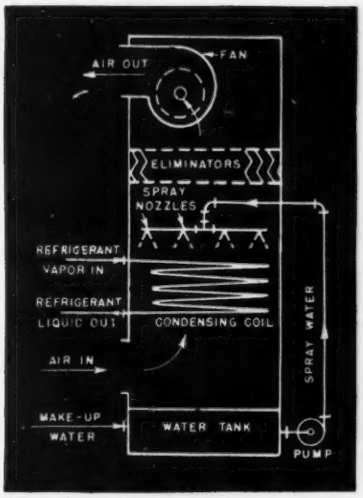

Fig. 2. Schematic diagram of evaporative cooler, showing the three essential parts: fan section, spray section, pump section

circulated by the fan through the coil and spray carries away the evaporated water and discharges it to the outside of the equipment. A ball float valve admits more water to the tank of the evaporative cooler as required by the evaporation of water from the system.

Capacity Ranges of Coolers

The capacity of an evaporative cooler is dependent on wet bulb temperatures. The capacity range of evaporative condensers for refrigeration systems is generally from 1 ton to 100 tons refrigeration in a single machine. For a large plant with refrigeration capacity in excess of 100 tons, several unit exaporative condensers can be used. This permits flexibility of operation, allowing only part of the system to be operated under small loads.

The accompanying Table I gives a condensed rating and dimension table of a line of evaporative condensers.

The selection of proper evaporative cooling equipment is based on the maximum design fluid temperature conditions and the maximum design wet bulb temperature conditions. In New York City it is customary to design for a wet bulb temperature of 76 F.

How to Select Evaporative Condenser

In selecting an ammonia evaporative condenser, it would be quite usual to select it on the basis of 76 F entering wet bulb temperature and 96 F condensing temperature, which corresponds to 185 psi head pressure.

Figure 5 shows the relative capacity of evaporative condensers at various entering wet bulb temperatures. This indicates the condensing temperatures which might be expected from a piece of equipment at other than design conditions. The average wet bulb temperature in New York City during the summer months is 66 F. Figure 5 shows that, if a condenser is selected for 76 F wet bulb at 100 per cent capacity, at 66 F wet bulb it will have a condensing temperature of 86 F, which corresponds to 155 psi head pressure. This is considerably below the maximum design condition and represents a large power saving and capacity increase.

Figure 3 shows how the compressor capacity and the compressor brake horsepower vary with condensing temperature in a refrigeration plant. It will be seen that, over a period of average wet bulb temperatures, there is a considerable saving in horsepower and a considerable increase in compressor capacity over what might be expected if the refrigeration plant were equipped with a water condenser which was designed to operate at 96 F condensing temperature during the time of maximum water temperature, which is usually a period of several months.

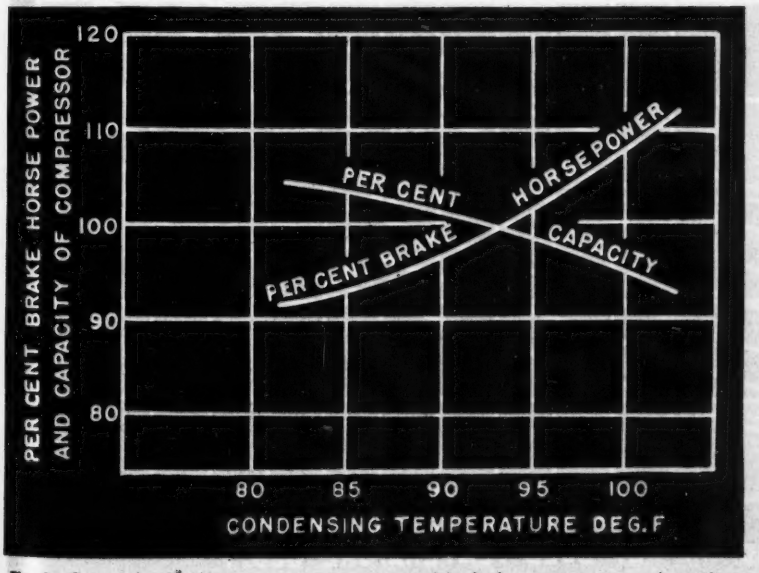

Fig. 3. Curves showing how compressor capacity and brake horsepower vary with condensing temperature in refrigeration plant

How to Install Evaporative Coolers

The installation of an evaporative cooler is a comparatively simple and inexpensive job. The space conditions may be observed from the sizes of the equipment in Table I. The evaporative cooler may be installed indoors or outdoors. However, outside air must always be brought to the air intake of the coolers. Outside air is cleaner and cooler than inside air. Also, the cooler should discharge its air to the outside. Discharge air is warm and humid and not suited for indoor discharge.

If installed indoors, both supply and exhaust ducts must be large, with full sweep bend so as not to restrict the air flow.

The equipment must be protected against winter operation, whether installed indoors or outdoors. It is not sufficient to rely on dampers in ducts for protection against freezing.

In the case of evaporative condensers, when the temperature of the outside air is 45 F, or below, the spray pumps may be shut down and water drained from the pans.

This does not usually apply to other evaporative cooling equipment, because its dry air capacity is not equivalent to its sprayed capacity, even though there is a wide temperature difference with cold entering air. Here a system of ducts and dampers for recirculating the air under automatic control, and also a means of adding heat to the spray water with either steam or electricity, should be provided. When the equipment is installed outdoors, the fluid, water and

Fig. 4. View of a typical evaporative cooler unit

steam lines can be run together, insulating around the entire pipe bundle to keep from freezing. As steam is used only when heating is necessary, this would not affect the capacity under cooling conditions.

How to Operate and Maintain Coolers

One of the difficulties of evaporative cooling equipment is that there may be scale formation on the outside of the cooling coil, due to the deposit of salt and dirt left on the coil by the evaporating water. This scale, however, will adhere to the coil only if the coil is hot enough to bake it on. A full, thorough spray goes a long way toward removing the deposits on the coil before they are baked solid.

Water treatment to prevent scale formation may be required in some instances when fluid temperatures are high and water is bad.

On evaporative condensers, a pre-cooling coil,* which removes the superheat from the refrigerant gas before it enters the sprayed coil, has been very effective in preventing scaling of the cooling coil.

The maintenance of evaporative cooling equipment does not require special treatment. The main points are shown in Table II.

Desirable Design Points

The proper design of evaporative cooling equipment for constant, year 'round, full capacity, should incorporate the points shown in Table III.

1. Sturdy, low-speed fan wheels
2. Rugged coil
3. Heavy casing, protected inside and outside from corrosion. It must be remembered that the weather inside an evaporative cooler is always as bad as the worst wet, rainy day outside.
4. Ample size fan and pump motors, with proper overload and voltage failure protection.
5. Adequate sprays to drench coil fully and completely to carry away any salts or dirt left by the evaporative water.
6. Use of proper metals of construction to withstand both the corrosive effect of the fluid inside the coil and the sprayed air stream outside the coil.

*A patented feature, developed by the author's company, and known as the Duo-pass.

Table II. Main points to check in Evaporative Cooler Maintenance

1. Lubrication of fans and motors
2. Cleaning of strainers, sprays and tank
3. Tightening of fan belts
4. In the case of evaporative condensers, the removal of oil or non-condensable gases from the inside of the coil.

7. Proper treatment of the fluid to be cooled and also the spray water, if the conditions of operation are likely to make either of these corrosive. It may happen in closed systems of water circulation that the water will get extremely acid, which is corrosive to piping and coil.
8. Maximum protection against scaling by the use of pre-cooling coil in evaporative condenser and full, heavy sprays in any evaporative cooling equipment.
9. Maximum protection against winter freeze-ups and under temperature conditions. This protection can be provided by the inclusion of ducts and dampers for recirculating air control, and also the addition of heat, either steam or electric, as required by automatic controls.

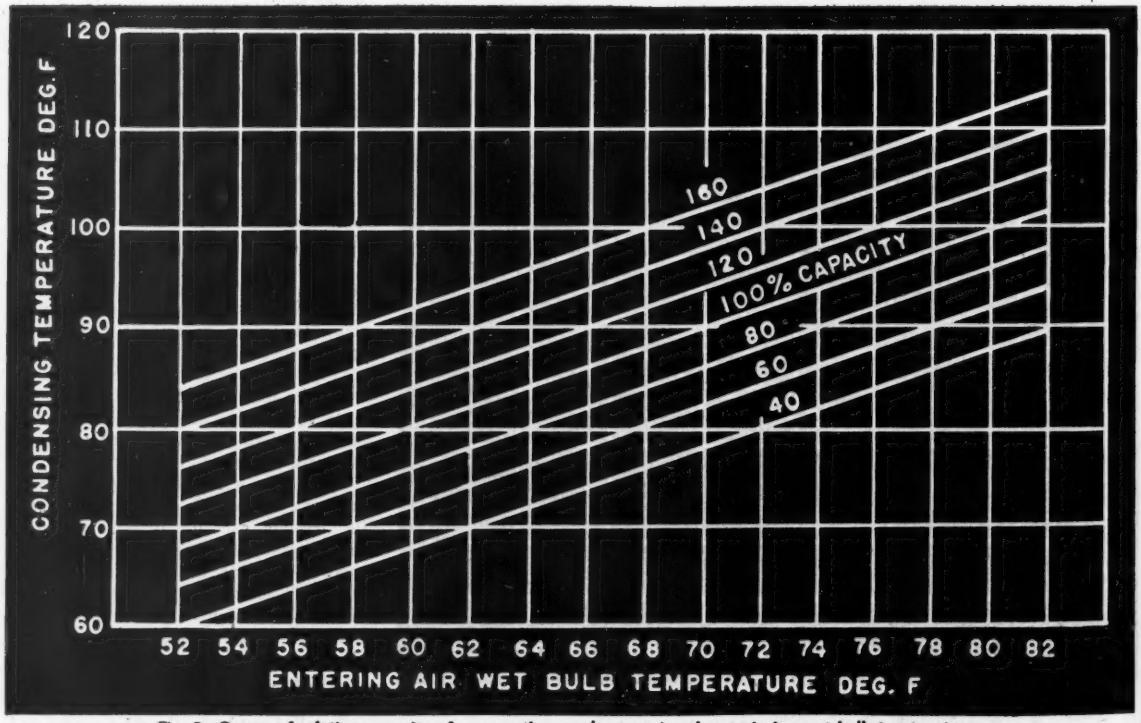

Fig. 5. Curves of relative capacity of evaporative condensers at various entering wet bulb temperatures

Babbitt Bearing Metals Developed During Wartime

War Production Board placed a limit of 12 per cent tin in babbitt for bearings . . . Gravity cast bearings and centrifugally cast bearings discussed . . . Casting methods described . . . Babbitt metals investigated and results of experimental work given . . . Babbitt thickness recommended . . . Bonding babbitt to cast iron accomplished . . . Brittleness controlled by annealing

By T. E. EAGAN, Chief Metallurgist, The Cooper-Bessemer Corp.

AN IMPORTANT problem facing engine designers, engineers, mechanics and maintenance men is what to do to offset bearing failures now that the War Production Board has ruled that no babbitt containing more than 12 per cent tin can be used for babbitting any bearings except those to be used in "implements of war".

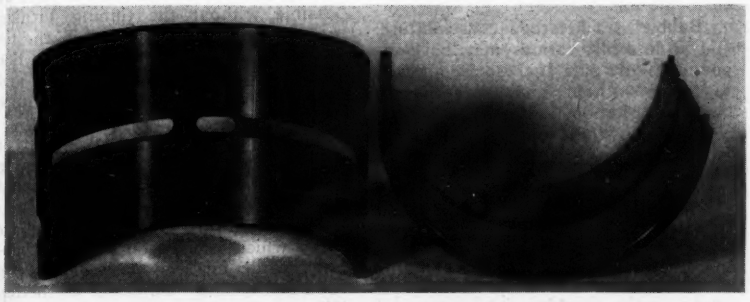

Fig. 1. Diesel engine main bearing shells with lead-arsenic babbitt 0.025 in. thick on Meehanite metal backing

The only concession to the above ruling is that existing Diesel engines, turbines, mining and quarrying machinery, locomotive connecting rods or side rod bearings can use high tin content bearings provided the design is such that it would be impossible to substitute a lead base bearing.

This wartime restriction presents a serious problem to many users of babbitt who have been accustomed to so-called "genuine babbitt" or a similar alternative. There are, however, several lead base babbitts having considerable merit, one of which will be discussed later in this article.

The two types of bearings to be discussed are the gravity cast bearing and the centrifugally cast bearing, the latter of which is considered to be far superior.

Gravity Cast Bearings

It has been a general rule that gravity cast bearings shall be made of thick babbitt with anchor grooves, and without any particular attempt to do much about the bonding. No bearing, however, is any better than its bond. Some of these bearings are extremely large and many are cast without tinning at all. Therefore, anchor grooves must be relied upon to hold the babbitt in place. Many times the babbitt cracks in the bearing after a short period of use, yet these bearings have continued being used under low pressure and low speeds even when cracked. It is much better, however, to have tin or some other type of bond on the bearing.

In order to get a good tinning job, it is of course necessary for the surface of the metal on which tinning is to be done to be chemically clean. This is a logical conclusion because in tinning a bearing we must rely on the chemical combination of the tin and the backing in order to form a chemical bond. This reaction cannot take place unless the surface of the backing is chemically clean.

The following criticism of gravity casting of bearings is made only for constructional reasons. In the old days, babbitt was poured around the shaft with some sort of packing to hold it in place, and that was considered a good bearing. With the development of engines and other moving parts this was abandoned, and special bearings were made to fit around the shaft or moving part. These were usually cast in regular babbitting fixtures. For economic reasons this was the best method of making a bearing but very little scientific thought was given to the problem of casting a bearing by this method.

Fig. 2. Churning procedure for static cast bearings

It must be considered, in casting any bearing, to arrange the methods so that the proper foundry practice can be followed, remembering that babbitt, after freezing, will shrink and must have some sort of a shrink head to take care of such shrinkage. Most bearings, therefore, should be cast in a vertical position. This allows babbitt to be poured in at the top of the bearing, filling up the bearing to the top and allowing it to cool properly. But here, one important thing is neglected and that is to get a bond between the babbitt and the backing.

As stated before, the ideal way is to have a chemically clean surface which is then tinned with the proper tinning metal. In the large bearings with anchor grooves, however, this is not always possible. So the method followed involves the machining of grooves in the bearing, where possible, or if the grooves are actually cast in, the surface is ground with a hand grinder until the dirty surface of the metal is supposedly removed. The surface is then coated with a mixture of copper-sulfate and water with a few drops of sulfuric acid in it. Copper will deposit on the surface if the bearing is chemically clean.

This process is repeated until the bearing has a complete copper coating. The bearing is then washed with a little "household" ammonia to neutralize any acid, and to remove any excess layers of copper. If the copper is thick it will not make a good bond. The bearing is then rinsed with water and

Fig. 3. Machine used for the centrifugal casting of bearing shells

fluxed with a zinc-chloride acid flux. We did find that these fluxes were variable and subsequently established either Grasselli No. 1 or Bruko as our standard fluxes. The use of molten zinc chloride is not recommended. The bearing is then placed into the molten tinning metal.

For tinning lead-base bearings, we use 20 per cent tin and 80 per cent lead, although there are several other metals that can be used and which are still within WPB limitations. For tin base babbitts we still use pure tin for tinning. This tinning metal is heated between 550 and 600 F. The bearing is then totally immersed in the bath until it reaches the temperature of the tinning metal. While the bearing is in this tinning bath, the jigs and fixtures are heated to between 300 and 600 F depending on the size and shape of the jig and the bearing, and finally on the thickness of babbitt to be poured. Thin babbitt should have hotter jigs.

The bearing is then taken out of the tinning bath, assembled in the jig, and the babbitt is then poured. This must be done quickly so that the heat in the bearing is not lost. If the tinning metal freezes on the bearing, it will not be remelted by the babbitt and a bond will not be obtained between the two metals. This idea of keeping the tin molten on the bearing proper is important. Unfortunately, a bond is impossible when the tin is not molten.

Jigs and Fixtures

It seems that many companies do not have proper jigs and fixtures to allow the most speedy assembly of the bearing into the jig. Furthermore, there is usually no effort made to seal the jig to prevent the babbitt from leaking out after it has been poured. When jigs are made properly, however, so that the babbitt can be sealed in easily, there will then be much greater likelihood of obtaining a good bearing.

We have found that with a properly designed jig, almost any bearing can be assembled in its place and the babbitt poured within 30 to 45 sec after it is taken out of the tin bath. In this length of time we are quite sure that there is not enough heat loss to allow the tin to solidify on the surface. As soon as the babbitt is poured into the tinned bearing after assembly in the jig, we churn the babbitt with strips of metal which are about $\frac{1}{16}$ in. thick, ½ in. wide and long enough to reach the bottom of the bearing. We continue to churn the metal until the bearing is solidified up to the top. We attempt to have the bearing freeze from the bearing backing to the mandrel instead of from the mandrel to the bearing. The best way to accomplish this is to have the mandrel hot enough so that the metal will freeze in the proper direction. Also, it should freeze from the bottom up to the top.

Babbitt is a heterogeneous mixture, and as it cools, various metallic compounds freeze out. If these are allowed to freeze without some sort of mechanical agitation, there is a tendency for them to come out very suddenly from an under-cooled state. When this occurs they are unsatisfactory.

The babbitt does not freeze at one temperature, but starts at one temperature and continues to freeze as the temperature drops. The temperature sometimes drops from 100 to 250 F. A study of the equilibrium diagrams of freezing of alloys shows that as the solid part freezes out, the liquid part changes in composition. If, therefore, this babbitt is allowed to leak out segregation and non-uniformity will ensue, causing the bearing to fail in operation. The correct pouring temperatures of babbitt have been carefully determined and are published. If we should get out of the proper temperature range, we are likely to get brittle, unsatisfactory babbitt.

Centrifugally Cast Bearings

From a metallurgical standpoint, gravity cast bearings are extremely poor when compared to correctly cast centrifugally cast bearings. In centrifugally cast bearings the problem of bonding is one of the most important factors. Here again the bearing must be chemically clean and a proper tinning job must be done because in most cases no anchor grooves are provided. The bond between the babbitt and the backing must be absolutely reliable. To get a chemically clean surface is relatively easy if proper equipment is used such as a relatively new process for cleaning bearings to be discussed later. The old process, however, is perhaps the cheapest to install, especially for steel backed centrifugally cast bearings. First, we have found that the limit of carbon content for steel backing to get the proper tinning is about 0.25 carbon. Babbitt with a greater proportion of carbon than this does not bond as well. The lower the carbon the better. Therefore, all shells are made of SAE-1010, SAE-1015 or SAE-1020 carbon steel. These are machined and the final cut taken on the inside of the bearing without any cutting compound. We desire a finish on these bearings which we call a "phonographic" finish, because it looks like a phonograph record. Sharp tools are used and every effort is made to have the steel cut and not smeared over the surface, as cold working causes trouble in tinning. These bearings are then electrolytically cleaned in an alkali solution. They need not be electrolytically cleaned, as they may be boiled in an alkali cleaner, a number of such cleaners being available. They are then etched in a 50 per cent solution of hydrochloric acid, running at 160 to 180 F, then rinsed and dipped into a zinc-chloride acidulated flux such as Bruko. From there they are placed into the tinning metal, depending on the type of babbitt, running at 550 to 600 F. The temperature of this tinning metal should be just as high as possible without the tinning turning brown when removed. That is, the tin must not oxidize on the surface. For pure tin the temperature is 560 F and for 20-80 composition the temperature is 575 F.

The bearing is then taken out of the bath and placed in the spinning jigs, spun, and babbitt is then poured into it. The cooling rate of the spinning is controlled by a water and air spray which is used on high tin babbitts, while for lead base babbitt we use a fast cooling—the faster the better. When finished the bearings are accurately machined to within limits of plus and minus 0.0002 in.

Cleaning Bearings

The Kolene process is the best for cleaning bearings that we have ever seen. With this process it is possible to bond chemically babbitt to cast iron. This is something which we have never before been able to accomplish. It works equally as well on steel and I have been told that it can be used on high alloy (SAE-4140) steels for some of the babbitted bearings used on aeroplanes. The Kolene process consists of two baths. One bath is a molten salt bath which runs between 760 and 800 F. This is a very highly oxidizing bath and puts a coating of oxide on the surface. In the case of cast iron it actually burns some of the graphite flakes on the surface. It also has a tendency to decarburize the surface of the bearing. As stated before, the less carbon, the better. The shell as it comes out of this bath has a coating of oxide on it and has a dark or black tone. It is then rinsed and placed in a highly alkaline bath, which is a water solution, that dissolves off this oxide.

The shell is again rinsed and given a very quick dip in a cold 10 per cent hydrochloric acid solution. This neutralizes any alkali that has not been rinsed off. Without rinsing, the shell is then placed into zinc-chloride liquid flux, and then into the tinning bath. The salt used for the first bath is quite

hydroscopic. Also, the alkali bath has an end product of ammonia and therefore must be placed under a hood in order to carry away the fumes. The results obtained are so good that we have been willing to put up with the difficulties of handling the baths.

As stated before, WPB has restricted the use of tin or babbitts containing more than 12 per cent of tin to the use of "implements of war" and they definitely designate what an "implement of war" is. Therefore, we were forced to consider lead base babbitts instead of tin base babbitts. Leaving all of the trade-name babbitts out of the picture, I wish to mention one type specifically—lead-arsenic babbitt, containing: 17.5 per cent antimony, 1 per cent tin, 1 per cent arsenic and 0.4 per cent copper and the remainder (70.1) lead. This analysis is given in ASTM specification B-23-26—Emergency Alternate spec. No. 16 or No. 13.

This babbitt was first discussed at length at the ASM meeting in Philadelphia two or three years ago. It was then stated that after two and one-half years of experimental work this lead-arsenic babbitt was found to be equal to, or better than, any tin base babbitt heretofore handled. Based on this research, we have done a considerable amount of experimental work with this babbitt. For instance, the bearing pressures on large Diesel engines are climbing higher as more power per unit size is required. This can be done in two ways. One way is to take the engine we have already designed and increase the speed, leaving everything else constant. This is a headache to the metallurgist, as increasing the speed and peak pressure in an engine will increase the load on the bearing from 800 psi to as high as 1900 psi. The allowable pressure on tin base babbitt of 1/32-in. is not over 1500 psi. The other method is to redesign the engine and make bearing areas larger. This usually means an increase in the size of the crankshaft and therefore increases the weight of the engine, and again we run into the limitation factor of pounds per horsepower which actually must be met. Our problem, therefore, was to develop a bearing that could take these higher pressures satisfactorily. This problem, coupled with the WPB ruling, led us to the testing of this lead-arsenic babbitt.

A set of lead-arsenic bearings was made to a standard production size normally employing genuine high tin babbitt, and placed on tests. The first engine on test had bearing pressure of 1350 psi and operated at 375 rpm. We carefully watched this test and found that lead-arsenic babbitt showed considerable improvement over the tin base babbitted bearings. On a newly designed engine on which the main bearing pressure reached 1900 psi, the tin base babbitted bearings with steel backs did not stand up more than a few hours under full load. We tried lead base babbitted bearings under the same conditions and found that they, also, failed under these terrific loads but examination of the bearings showed that the failure of the lead-arsenic bearings was not as serious as that of the tin base bearings.

On large, slow-moving engine bearings we have tried various lead-base bearings with little success. As the load on these engines is relatively light and the speeds low, we found that the bearings would slowly flow under the pressures and finally fail. Lead-arsenic bearings, however, tested in the same way, gave excellent results. In fact, we can definitely say that they stood up better than the tin base bearings we were then using which was not, of course, the genuine tin base babbitt but a babbitt that contained 20 per cent lead. Therefore, we have adopted lead-arsenic babbitt for all bearings where we can use it.

Babbitt Thickness

Tests showed that the bearing life does not increase until the babbitt is reduced to 0.012 to 0.014 in. in thickness. Thereafter the life of the bearing doubles and trebles as the thickness of babbitt goes down. Theoretically it should live forever with no babbitt on it, which, of course, is not true. It is a difficult thing to convince engineers that a bearing with 0.005 in. of babbitt on a steel back is satisfactory because they don't like to think that they have only 0.005 in. between themselves and disaster, should the babbitt go out. Consequently, "tri-metal" bearings were developed which are steel backed bearings with 1/16 in. of bronze on which is cast 0.005 in. of babbitt. These are precision-made bearings and we have adopted them as a general rule for high pressure engines. We have found that they stand up under terrific pressure and give much better life. Thinning the babbitt down always increases life.

On the engines where we still use babbitt on steel backs, we first had ⅛ in. babbitt. This was cut to 1/16 in. with an increase of life. This was cut again to 0.035 in. with another increase of life. We have tried babbitt with 0.008 in. thickness and found that we can get a great increase of life, so we believe it is safe to say that you can run a bearing with thin babbitt on steel with success. The same thing applies to lead-arsenic babbitt if it is handled properly.

Most steel-backed bearings are made from steel tubing which is difficult to obtain. We have attempted in many ways to get around the use of steel tubing such as using plate steel bends welded into a perfect circle, but steel offers difficulty as the welds have to be perfect and free from pin holes or flaws. Plate steel was also difficult to obtain. At this time the Kolene process came into the picture and we found that we could bond babbitt to cast iron. We made up bearings with cast iron backs and very interesting results were obtained. We have used lead-arsenic babbitt because it is a great conservation of tin. One set of bearings made of cast iron backs with 1/32 in. babbitt ran over 1400 hr in a test in a special engine which we had converted from gas to oil firing. These bearings were run under adverse conditions due to the fact that the engine was under test and development, so they were actually abused. They did not fail, however, and were perfect bearings in every respect. The cast iron-backed shells with lead-arsenic babbitt of 1/32 in. thickness were adopted for this type engine. We have recently completed

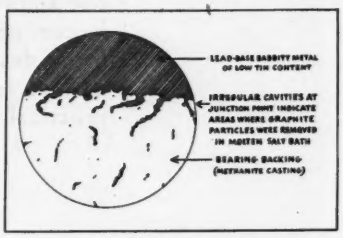
LEAD-BASE BABBITT METAL OF LOW TIN CONTENT
IRREGULAR CAVITIES AT JUNCTION POINT INDICATE AREAS WHERE GRAPHITE PARTICLES WERE REMOVED IN MOLTEN SALT BATH
BEARING BACKING (MALLEABLE CASTING)

Fig. 4. Enlarged drawing of microscopic view showing bond between babbitt and cast iron

a test where we put cast iron-backed shells in an engine where only the tri-metal bearings would last. Many tests have shown that we could use nothing else but tin based tri-metal bearings. These bearings, however, stood 900 hr running without failure. Consequently, we believe that perhaps cast iron backs must have something to do with the ability of this babbitt to stand up.

Our conclusion is that this lead-arsenic babbitt is the equivalent of high tin babbitt in every case we have tried. Furthermore, with cast iron backs it seems to give infinitely greater service.

In comparison to high tin babbitt this lead-arsenic babbitt is much more difficult to handle for two reasons. One is that its tendency to segregate is very pronounced; and secondly, it is much more brittle than high tin babbitt.

In the centrifugally cast bearing a considerable amount of study must be given to the way in which the babbitt is handled. Attention should be given to the revolutions per minute at which the spinning lathe is turning and to the rate of cooling. Lead, being heavy, will always go to the outside and the little particles of hard material which make up the babbitt metal will, therefore, go to the inside diameter of the bearing. Therefore, it is possible to segregate this babbitt in such a form that when the inside diameter of the bearing is turned, you will machine off all of these hard particles and leave nothing but a lead-antimony compound. Another factor that must be taken into consideration is that no matter how slowly you turn the bearing it must be cooled very rapidly in order to hold these particles where they come out of solution. This is extremely important.

Brittleness may be partially eliminated by annealing very close to the melting point of the babbitt. The temperature must be held accurately, of course, or the babbitt will be melted out of the bearing. We have found that a pouring temperature of 950 to 975 F is correct for both gravity and centrifugally cast bearings.

Selecting and Applying Commonly

Engineers are often confronted with the problem of selecting a control for a particular type of motor drive. There are a great many types of control available and unless one knows something about the various types of control it is confusing to make a selection. This article by W. J. Stock describes the various types of control and the applications for which they are most suitable. It is of direct practical value to the operating man and the designer

By W. J. STOCK
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THE IMPORTANCE of a motor control depends on the function it performs for the motor with which it is used. The motor and its control, correctly co-ordinated to operate as a unit, make up an electrical drive.

The motor has but one purpose—to furnish rotating force (torque) at the shaft. This simple rotating force can be utilized in numberless ways by placing it under control. The control is that part of the drive that makes the motor do what is desired. But the starting, stopping, and reversing of an electric motor are only a few of the contributions that motor control makes to the efficient operation of the modern electric drive.

The following list of common control functions will give you a broader conception of motor control, and will help you to better understand why control is popularly called the brains of electric drive.

Functions of Control

To Limit Torque on the Motor and the Machine

You have seen how the belt of a motor-driven machine often runs off the pulley when a motor is started. The pulleys may be correctly lined up, and the belt tension may be correct, yet the belt is thrown off in starting. This is the result of applying torque too quickly at standstill, and can be avoided by limiting the torque on the motor in starting. As another example, the blades on centrifugal fans may be sheared off if too much torque is applied to the fan in starting. This can be prevented by applying a small torque at the outset, then, applying full torque when the fan is partially up to speed. The limiting of torque during starting is one of the most important functions of control.

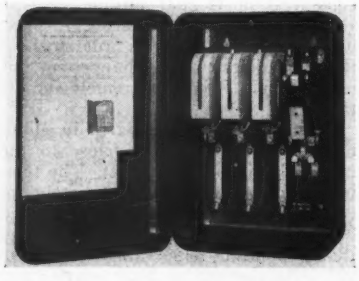

Fig. 1. Enclosed magnetic contactor

To Limit Starting Current

It is a common sight to see d-c motors flash over at the commutator when too much current is applied to the motor in bringing it up to speed. Also, it is common to see lights blink when a motor on the same power circuit is started. True, this blinking of lights can be improved by selecting a motor with the right characteristics, but, in general, the real answer is the selection of a control that limits the starting current, either by inserting resistance in the circuit or by using a reduced-voltage source of power.

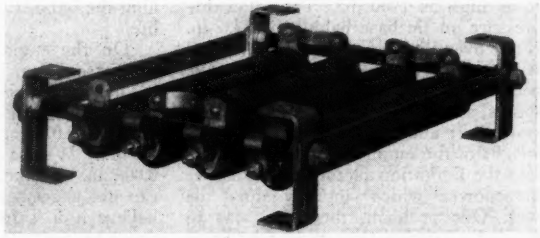

Fig. 2. Power-absorbing resistor consisting of four units mounted in a frame

To Protect the Motor from Overheating

Motors are designed to radiate a sufficient amount of heat to permit the motor to produce full-load torque for a definite period without overheating. While the motor is capable of exceeding its normal output for limited periods, there is nothing inherent in the motor to maintain its temperature at a safe limit. It is, therefore, the job of the control to prevent the motor from overheating excessively without shutting it down unnecessarily, if the heat generated during that overload is not sufficient to damage the windings.

To Stop the Motor Quickly

Where a driven machine has high inertia, it will continue to run for a considerable time after the power has been disconnected. There are several types of control—such as electric brakes—to stop a motor quickly, and the one most generally used on a-c motors is the plugging switch. To plug a motor, it is necessary only to disconnect it from the line, and then reconnect it to the line so that the power applied to the motor tends to drive it in the opposite direction. This counter-torque, acting against the inertia of rotation, brakes the motor rapidly to standstill, at which time the reverse power is cut off.

To Regulate Speed

Fans for furnishing ventilation to a building are sometimes run at various speeds, depending upon the ventilation requirements. On some applications, it is advisable to use a two-speed motor, but where a variety of speeds are required, a constant speed motor, with adequate control, may be the best solution to the problem.

Other Functions

Adequate control equipment covers various other protective functions which are not as common as those enumerated above. Among these are reverse-phase protection, which prevents a motor from running in the wrong direction if a phase is inadvertently reversed; open-phase protection, which prevents the motor from running on single phase in case a fuse blows; and under-voltage protection, which prevents a motor from restarting after a power failure unless it is started by the operator. Undervoltage protection, because it is unusually important, will be discussed later.

Used Motor Control Devices

Simplicity of Control

Many persons who are not very familiar with control have the impression that it is very complicated. Usually, this impression has been created by looking at some very complex special-purpose control, such as that used in a steel mill, in a paper-making plant, or in a printing plant.

When taken as a whole, the control for these drives is complicated, with dozens of devices interlocked and sequenced, and with hundreds of control wires and cables running between devices used in the control scheme. However, these controls are really not as complex as they might seem at first glance. They actually consist of simple, basic, control devices that have been interconnected to provide a very special type of operation.

In general, every industrial control device is made up of one or more of the following four control parts:

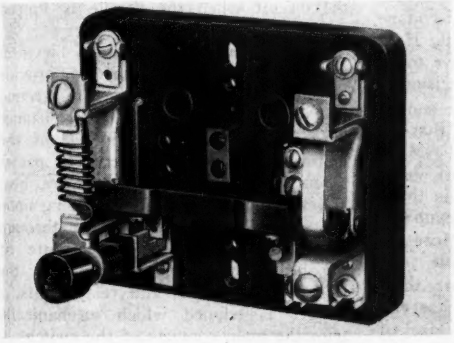

Fig. 3. Two-element temperature overload relay with one heater removed

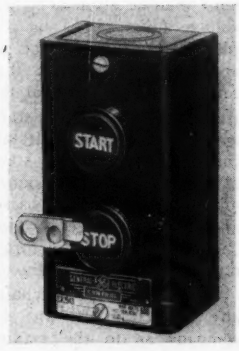

Fig. 4. Momentary-contact push-button station

1. Switching Mechanisms

In this group is included any device which opens and closes power circuits, such as the ordinary knife switch and the magnetic contactor (Fig. 1). These devices, of course, are available in a variety of ampere sizes and different numbers of poles, but this does not basically complicate the situation.

2. Absorbing or Power-transforming Devices

In this category are included those devices, such as resistors (Fig. 2) which absorb part of the power applied to the motor, and transformers or auto-transformers, which reduce the amount of voltage applied to the motor.

3. Protective Devices

Here are included devices which operate on temperature (Fig. 3), voltage, frequency, or time, and cause the switching mechanisms to operate when some predetermined set of conditions exists.

4. Pilot-circuit Devices

In this group are included initiating devices, such as push-buttons (Fig. 4), selector switches, float switches, and pressure governors.

By thinking of these four classifications when the various control devices are discussed in this article, you will get a much clearer picture of just what these devices accomplish, and how basically simple they are.

The Selection of the Correct Control

Because a-c power is so generally used throughout industry, this discussion is confined largely to a-c drives.

In discussing the application of control, it is assumed that the necessary information regarding the general requirements of the application have been determined, and that the motor has already been selected correctly. On this basis, some of the problems, which are before us in our attempt to select the correct control for the job, now can be discussed.

Manual vs. Magnetic

The first broad point to be considered is whether the situation warrants the selection of manually operated or magnetic control.

A manual controller is a controller having all its basic functions (such as starting, stopping, accelerating, or reversing) performed by hand. A good example of this is the drum switch used on the trolley car.

A magnetic control is a controller having all its basic functions performed by electromagnets. A typical magnetic control may require the operator to push a button to initiate the starting, but the magnetic control carries on from there and really does the work.

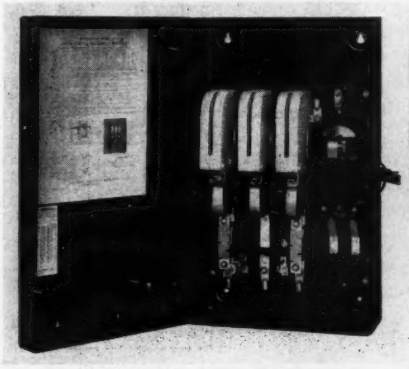

Fig. 6. Full-voltage, three-pole switch

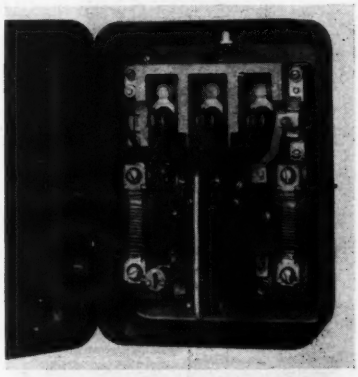

Fig. 5. Full-voltage three-pole magnetic starter

In deciding between manual and magnetic control, here are some factors that should be considered:

1. If the motor is small or is started infrequently, manual control may be entirely adequate. If the motor, however, is started frequently, say twelve times an hour or more, and is operated on this duty cycle week after week, the purchase of magnetic control may be economically justified. Magnetic control is made to stand up under frequent operations, and the higher price for the magnetic control may be more than offset by the lower maintenance and repair costs. In most instances, it is easier to service magnetic panels than manual devices, and if repairs are necessary, it may take less time to make the repairs on the magnetic equipment than on the manual.

Manual controllers are limited in size and, if the motor is a large one, no manual control may be available.

2. The manual device must be mounted where it is convenient to the operator, and in the case of a machine it may be that the most convenient place

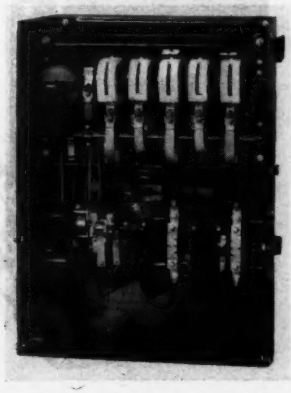

Fig. 7. Reduced-voltage magnetic starter with front cover removed

Fig. 8. Enclosed-type motor-starting switch, for surface wall mounting

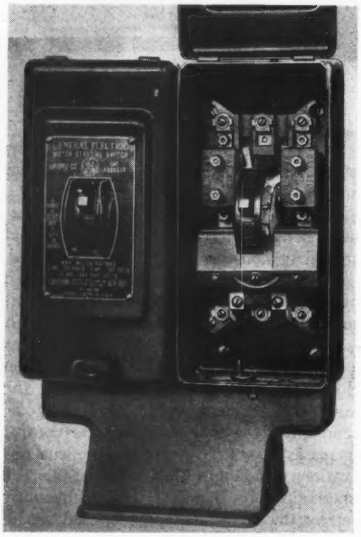

Fig. 9. Two switches mounted on pedestal

Fig. 10. Hand compensator for manual reduced-voltage starting

is on the machine itself. However, it may be difficult to find sufficient space for a control of the manual type. The problem can be solved by using magnetic control mounted on the ceiling or on the wall away from the machine, and operating the magnetic control from a small push-button or master switch mounted on the machine.

3. A magnetic control is usually automatic in operation, and does not require too intelligent a person to operate it. The correct use of a manual control puts some responsibility on the operator, and unless he can be trained to use the manual controller intelligently, the motor, as well as the machine which it drives, may be abused.

4. If it is essential that the motor be controlled at a remote point, then the magnetic control is almost a necessity.

FULL-VOLTAGE VS. REDUCED-VOLTAGE STARTING

Having arrived at a decision as to whether manual or magnetic control is to be recommended, due consideration must then be given as to whether a full-voltage (Figs. 5, 6) or reduced-voltage starter (Fig. 7) is to be selected. Here are some of the factors that have to be considered in arriving at this decision.

1. Will the machine stand the sudden application of torque at starting that occurs with full-voltage starting? Many machines involving a number of gears may have considerable backlash in them, and it may be necessary to take up the backlash with reduced torque before applying full torque to the machine.

2. If power is purchased, are there any restrictions by the electric service company as to the maximum size of motor which can be started on full voltage? Many times a casual inspection of other motors connected to the same power source will answer this question. For example, with a 25-hp motor to start, it might be found that on the power source to be used, a number of 200-hp motors are connected and started on reduced voltage. In such a case, it is quite possible that the in-rush current on a 25-hp motor will be less than the current taken from the line by the 200-hp motor with reduced-voltage starting. In this instance, full-voltage starting of the 25-hp motor will undoubtedly be acceptable.

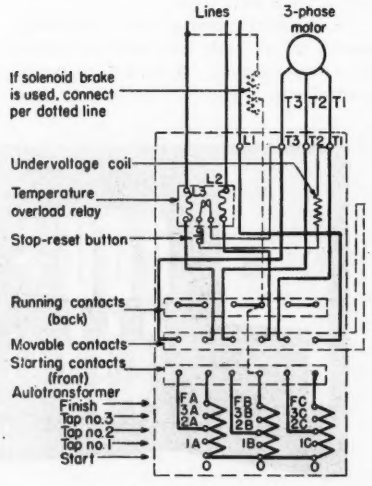

Fig. 11. Wiring diagram of hand compensator

What Manual Starters Are Available?

Having now decided on whether the control is to be manual or magnetic, and also whether it is to be for full- or reduced-voltage starting, the next point is the actual selection of the control for the particular motor. In looking over the following available controls, let us assume that a manual controller will be adequate and that full-voltage starting is permissible.

SNAP-ACTION SWITCH FOR FRACTIONAL-HORSEPOWER MOTORS

If the motor is of a fractional type, the starter illustrated by Fig. 8 is right for the job. This starter resembles the ordinary snap switch, but is sturdier in construction. It closes the motor circuit when the handle is flipped up, and opens the circuit when the handle is flipped down.

In addition, it contains a solder-film temperature overload relay to provide overload protection to the motor. Around the solder film is a coil of resistance wire which is connected in one of the motor lines, and as the current passes through this coil of resistance wire, heat is generated, the amount depending upon the amount of current flowing through the heater. When the temperature of the heater reaches a point where the solder in the solder-film relay melts, a trigger is tripped which mechanically trips the main contacts of the switch.

After the relay has tripped, the solder hardens, and to reset the tripping mechanism it is necessary to pull down the operating handle of the switch. It is then possible to flip the operating handle up and start the motor. The relay cannot be reset before the solder hardens.

SNAP-ACTION SWITCH FOR INTEGRAL-HORSEPOWER MOTORS

For motors up to 7½ hp, 440 v, another switch (Fig. 9), really a "big brother" of the type shown in Fig. 8, is available. The same type of solder-film overload relays is included. Both of these switches are trip-free; i.e., the operating handle cannot hold the main contacts closed on an overload. This makes it impossible for a careless operator to hold the operating lever up and keep the motor energized under overload conditions which might cause it to burn out.

In these two starters, we find only two of the basic control parts, the switching mechanism and the protective device.

COMPENSATORS

Assuming that a manual reduced-voltage starter is called for, hand compensators of the type shown in Fig. 10 are available. As shown in Fig. 11, this compensator consists of an autotransformer, a manually operated set of contacts, and a temperature overload relay. When the operating handle is pushed away from the operator, the autotrans-

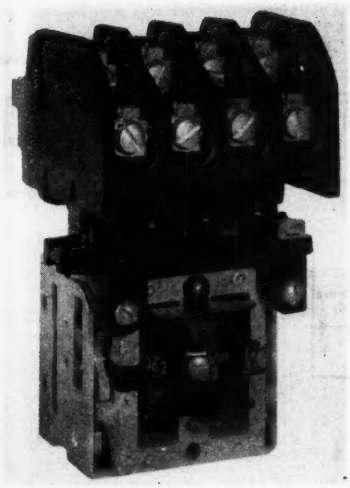

Fig. 12. Three-pole, size 1, magnetic contactor, with extra pole as holding interlock

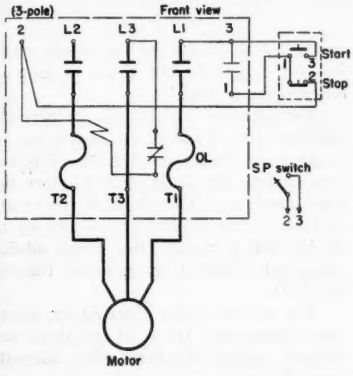

Fig. 14. Wiring diagram for magnetic starter shown in Fig. 13

former is connected to the power source, and at the same time the motor being controlled is connected to taps in the autotransformer, which apply 50, 65, or 80 per cent of line voltage to the motor. This reduced voltage materially limits the torque on the motor in starting. In fact, the torque varies as the square of the applied voltage. If, for example, the 50-per cent tap is used, the torque applied to the motor on starting will be 0.5 squared or 25 per cent of the full-load torque; or if the 80 per cent tap is used, the torque will be 0.8 squared or 64 per cent of the full-voltage starting torque.

After the motor has accelerated, the operator quickly pulls the handle back to the running position, which connects the motor to full-line voltage. The handle is held in the RUNNING position by an undervoltage trip coil. If the overload relay trips out, line voltage falls momentarily, or if the cover is removed, the undervoltage coil is de-energized, and this allows the handle to return to the OFF position. To restart, the overload relay must be reset by pushing a reset button on the outside of the case. Then the operating lever must be thrown first to the starting, and next to the running position. It is not possible to throw

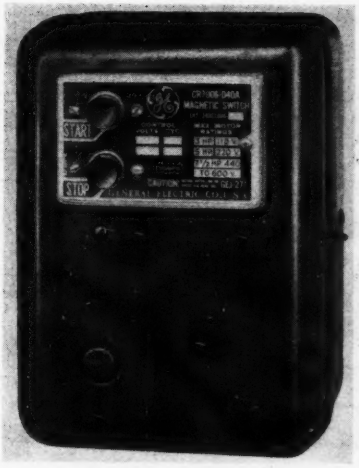

Fig. 13. Typical magnetic starter

the operating handle from the OFF position directly to the RUNNING position (this would start the motor on full voltage), because the handle is so interlocked that it must first be pushed to the starting position before it can be pulled through the OFF position to the running position.

In this compensator, there are three elements of the fundamental control parts; namely, a switching mechanism, a power transforming device, and an overload protective device.

This completes the line of standard manual starters available for both full- and reduced-voltage starting.

What Magnetic Starters Are Available?

Now, assume that conditions indicate the choice of a magnetic device and that full-voltage starting is permissible.

THE CONTACTOR

The simplest controller is a standard magnetic contactor (Fig. 12); it may be either double- or triple-pole but the latter is preferred for starting motors. This device is seldom used as a motor starter for the reason that it does not include overload protection, but is more generally used for handling lighting or heating circuits where overload protection is not essential. However, this same contactor can be obtained with an overload relay as a part of it, in which case it is known as a magnetic starter (Figs. 13, 14).

MAGNETIC STARTERS

The starters shown in Fig. 13 is an ordinary two-, three-, or four-pole (for single-, two-, or three-phase circuits) contactor, together with an overload relay mounted in a metal enclosure.

Any industrial control device is designed so that it will safely make and break the stalled motor circuit of any motor for which it is recommended. Industrial control in itself, however, is not capable of handling or protecting itself from short circuits. In the case of the above magnetic starter, in order to provide short-circuit protection, as well as a means for disconnecting the motor and control from the line for servicing, a separate fusible safety switch or breaker must be provided by the purchaser. But the magnetic switch and short-circuit protective device can be combined in a single enclosure. In this case, it is called a combination starter (Figs. 15, 16).

COMBINATION STARTERS

These combination starters are available with the magnetic switch mounted in the same enclosing case with either a safety switch or a breaker. By combining the magnetic switch and the safety switch or breaker in a single case, some definite advantages are offered:

1. With only one enclosure to mount, and no wiring required between separate switches; this switch can be installed for less money and in a shorter time than a magnetic starter (Fig. 13) and separate safety switch.

2. The cover of the enclosure of the combination starter is interlocked with the safety switch handle so the cover cannot be opened when the safety switch is in the ON position, nor can the safety

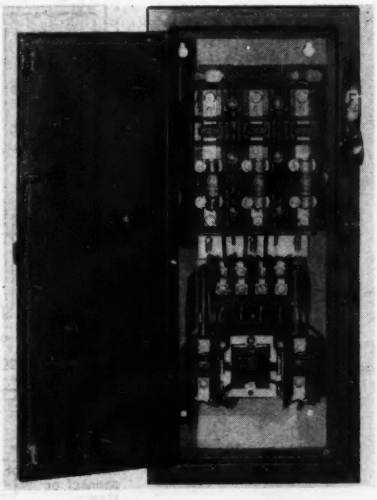

Fig. 15. Combination a-c magnetic starter with cover open

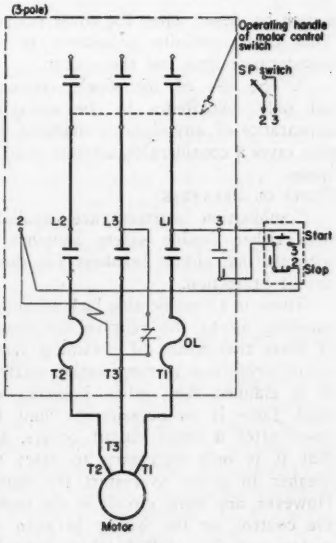

Fig. 16. Wiring diagram for combination starter

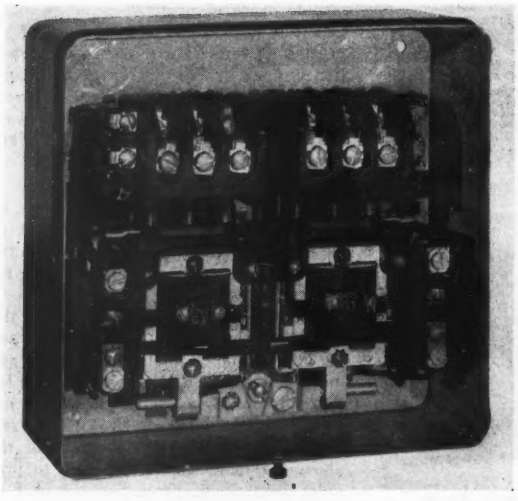

Fig. 17. A-c magnetic reversing starter with front cover removed

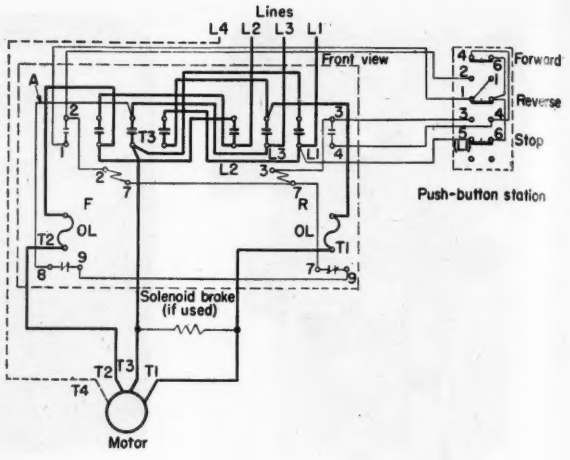

Fig. 18. Wiring diagram of typical reversing starter

Fig. 19. Autotransformer-type, reduced-voltage magnetic compensator with built-in undervoltage protection and overload protection

switch be closed when the cover is open. This offers definite protection to the maintenance man and the operator.

3. The use of the single enclosure not only contributes to the attractive appearance of any shop or machine, but also saves a considerable amount of plant space.

FUSES OR BREAKERS

Combination starters are available with either fusible safety switches or with thermal circuit breakers for short-circuit protection.

There is a considerable lack of understanding as to the relative advantages of these two means of obtaining short-circuit protection in combination starters. It is claimed that, when breakers are used, there is no occasion to hunt for fuses after a short circuit occurs, and that it is only necessary to reset the breaker in order to restart the motor. However, any short circuit in the motor, the control, or the wiring between the motor and the control that is capable of blowing a fuse or tripping a breaker usually results in some damage at the point where the short circuit occurred, and the time required to repair this damage far exceeds the time required to obtain and install new fuses.

It must be remembered that short-circuit protection is installed to protect the motor, the wiring, and the controller, and that the device that will open most rapidly will give the best degree of protection.

The ordinary nonrenewable-type fuse will open the circuit in ½ cycle. The thermal-type breaker, on the other hand, will require about four half cycles to interrupt the circuit. This means that, when using a breaker, a considerable amount of power is flowing through the controller, the wires, or the motor winding for a period four times as long as when using a fuse.

Furthermore, a fuse has a current-limiting effect which, in itself, has a tendency to reduce the amount of power flowing into the short circuit before the fuse can blow. Therefore, as short-circuit protective devices on motors up to 50 hp, 600 v, fuses offer many advantages not obtained when using thermal breakers.

For motors larger than 50 hp, where more expensive types of breakers are offered, circuit breakers offer adequate protection.

REVERSING STARTERS

The starters of Figs. 13 & 15 are

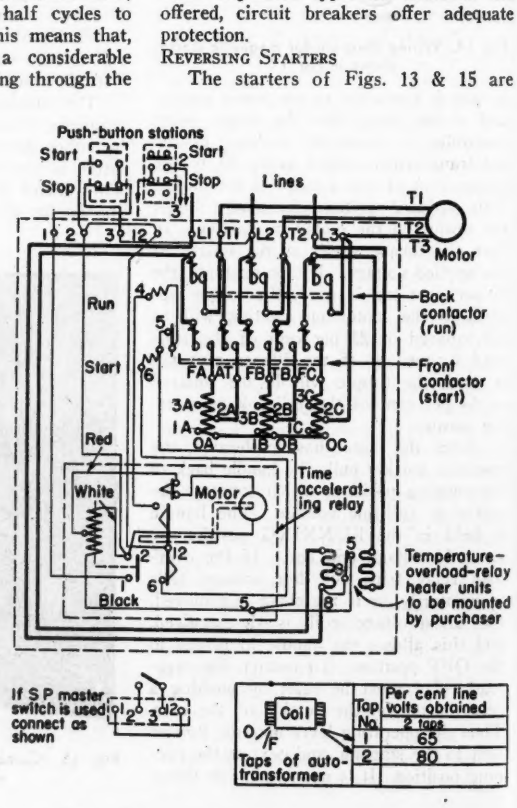

Fig. 20. Diagram for connection of reduced-voltage magnetic compensator with a three-phase, squirrel-cage induction motor

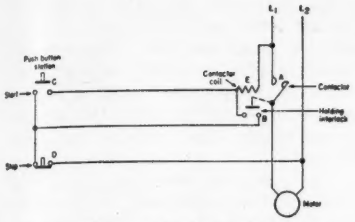

Fig. 21. Diagram showing undervoltage protection

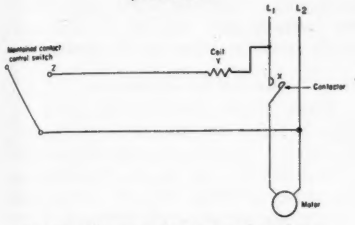

Fig. 22. Diagram showing undervoltage release

suitable only for non-reversing service, and occasionally it is necessary to furnish a control of this general type which can be used for running a motor in both directions. For this, there are available reversing starters (Figs. 17, 18). This consists essentially of the Fig. 13 starter to which has been added another contactor which is used for running the motor in the reverse direction. One set of overload relays is used. The reversing starters require 3-button push-button stations, or their equivalent, to operate them.

REDUCED-VOLTAGE STARTERS

If conditions warrant a magnetic reduced-voltage starter, an automatic compensator is available (Figs. 19, 20). This consists of an autotransformer similar to the autotransformer used in the hand compensator, a 3-pole, and a 5-pole contactor for switching connections, a timing relay for closing the running contactor at a definite time after the starting contactor is closed, and an overload relay. Assuming a START-STOP push button is used with the automatic compensator, pushing the START button closes the starting contactor, which connects the motor to the line on reduced-voltage taps. Simultaneously, the timing relay starts operating, and at a predetermined time the starting contactor opens and the running contactor closes, thus connecting the motor directly to the power circuit.

Relays

It has been pointed out that practically all of the various standard controls include overload relays, and a fairly complete description has already been given of the solder-film relay used on the snap-action switches for the control of small motors. But while the solder-type relay is adequate for smaller manual starters, a higher degree of protection than is offered by the solder-type of relay is justified on magnetic controllers. Therefore, on magnetic controllers, as well as on the hand compensator (Fig. 10) which ordinarily is used for larger motors, the General Electric Co. uses what is known as the bimetal or thermostatic strip type of overload relay.

This relay consists of a heater coil which is connected directly in a line to the motor, and which heats up in proportion to the amount of current flowing through it. Mounted adjacent to the heater is the strip of thermostatic metal anchored at one end, the other end being free to move. Since the thermostatic metal is made of two metals rolled together, each metal having a different expansion constant, the thermostatic strip will bend or warp when heated. Since one end is solidly anchored, all of the movement occurs on the free end. When the metal is cold, its end position prevents a trigger, on which control circuit contacts are mounted, from tripping. However, as the metal heats, the end moves along the trigger until it comes to a point where the trigger is allowed to trip, and then the control-circuit contacts open.

A relay of this type is quite accurate, and its operating characteristic is well-defined. It is possible to design a heater that will raise the temperature of the thermostatic strip at the same rate as the temperature in the motor with which it is being used, and to adjust the relay so that it will trip the control contacts when the temperature of the motor has reached the allowable maximum. Since some time is required to transmit the heat from the heater coil to the thermostatic strip, it is not affected by momentary current increases. This makes it possible to start the motor with an inrush of six to ten times normal current without tripping the relay.

It should be remembered that since the overload relay operates on current, it cannot be expected to protect a motor under abnormal conditions which do not cause the motor to draw more current. For example, it is possible for the bearings of the motor to become so worn that the rotor rubs against the stator. This may cause the windings to be burned out through mechanical friction, but this may not cause the motor to draw enough extra current to cause the relay to operate.

In order to design relays that adequately protect motors, a great deal must be known about motor characteristics. Access by control designers to the mass of information accumulated from all kinds of motor tests has permitted them to design a line of overload relays that are thoroughly reliable in operation.

Undervoltage Protection and Release

There is frequently some misunderstanding as to the difference between undervoltage protection and undervoltage release. However, confusion in the use of these terms can readily be cleared up by studying the following definitions and their accompanying diagrams.

UNDERVOLTAGE PROTECTION

Here is the definition of undervoltage protection: "The effect of the device, operative on the reduction or failure of voltage, to cause and maintain the interruption of power to the main circuit." American Standard.

How undervoltage protection is provided is indicated by Fig. 21. Contactor (A) handles the motor circuit. It contains a normally open holding interlock (B) which closes when the contactor is closed. The two button, push-button station consists of a normally open START contact (C) and a normally closed STOP contact (D). When contact is made momentarily at (C) by pressing the START button, the contactor coil (E) is energized and the contactor (A) closes, which, in turn, closes the interlock circuit (B). It will be noticed that interlock (B) parallels the START contact (C). The contactor is, therefore, held in through the interlock circuit (B) even after the START contact (C) opens up when the finger is removed from the button. In case of a voltage failure, coil (E) is de-energized and contactor (A) opens, which in turn opens interlock circuit (B). When voltage returns, the contactor will not close until the circuit is again established at (C) by pushing the START button.

UNDERVOLTAGE RELEASE

Here is the definition of undervoltage release:

"The effect of a device, operative on the reduction or failure of voltage, to cause the interruption of power to the main circuit, but not to prevent the re-establishment of the main circuit on return of voltage." American Standard.

Figure 22 is typical of a control providing undervoltage release.

This control consists of a contactor (X) for handling the motor circuit, and

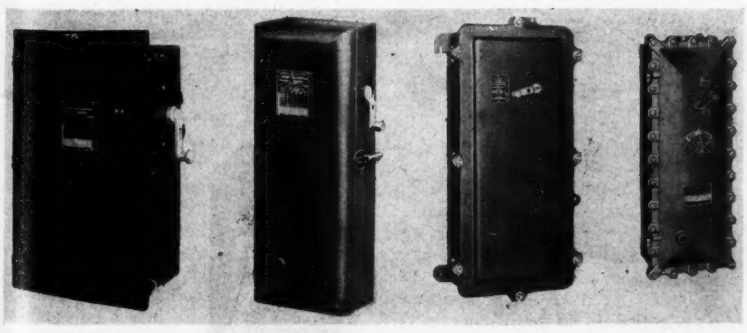

Fig. 23. (A) Dust-tight enclosure; (B) General-purpose enclosure; (C) Watertight enclosure; (D) Enclosure for hazardous locations

Fig. 24. Typical three-button push-button station

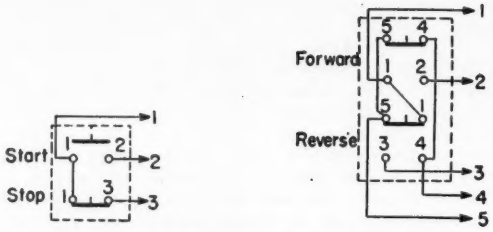

Fig. 25. (A) Wiring diagram for two-button station; (B) Wiring diagram for three-button station

a maintained-contact control switch (*Z*). Switch (*Z*) may be a knife switch, a float switch, a pressure switch, or a maintained contact push-button station whose contacts close and remain closed irrespective of voltage on them. To start the motor, the control switch (*Z*) is closed. This energizes the contactor coil (Y), and then contactor (X) closes, connecting the motor to the line.

Now, if voltage fails, the coil (Y) is de-energized and contactor (X) opens. However, nothing happens to contact (*Z*) as a result of voltage failure, and when voltage returns, the motor starts again.

When this type of control is used on certain machines, such as saws, millers, etc., there is always the danger that an operator may return to his machine, and—not realizing that the machine has stopped because of the momentary voltage failure—attempt to remove the saw or milling head. Obviously, this is dangerous practice. By providing undervoltage protection, this hazard is eliminated since the motor cannot start again, when the power returns after a voltage failure, until the operator presses the START button.

Enclosures

Most types of industrial control apparatus are enclosed in a general-purpose sheet-metal enclosure for indoor use. This enclosure is not ventilated and is reasonably tight. It serves as a protection against dust and light indirect splashings, but it is not dust-tight. In addition to the protection which it affords to the equipment mounted inside of the case, it also serves as protection to operators who might otherwise come in contact with a live part.

The smaller general-purpose enclosures are furnished with doors or covers which hook over dowel pins on the top of the case. The larger general-purpose enclosures are furnished with hinged doors since it is easier to open a hinged door on these larger enclosures than to lift off the cover.

While there is a total of nine other standard types of enclosures, those most frequently encountered are the dust-tight, watertight, and Class 1 and Class 2 enclosures for hazardous locations (Fig. 23).

Controls in dust-tight enclosures find application in cement mills, foundries, or other places where the air is filled with fine dust.

The watertight enclosures are made of heavy sheet metal or cast iron, and can be hosed down without water getting inside the enclosure. They are generally applied on outdoor installations, and in dairies, breweries, and similar locations.

The Class 1 enclosures for installations in hazardous areas are made for both air-break and oil-immersed control. The enclosures for the air-break control are heavy enough to withstand an internal explosion and prevent hot gases from escaping to the outside. The oil-immersed control for hazardous areas is submerged six inches below the oil level so explosions are prevented.

Oil-immersed devices are also used where corrosive atmospheres are present, since oil protects the metal parts from corrosion.

The enclosures for Class 2 application are made sufficiently tight to prevent dust from entering. This type of control is used principally in grain elevators, flour mills, etc., where a collection of dust mixed with the proper amount of air might form an explosive mixture.

The controllers described up to this point are those which are so commonly used that familiarity with them is essential. In addition, there are available many other controls which experience has indicated are required to take care of all conditions that are encountered.

Control for D-C Motors

Some of the controls like those of Figs. 8 and 9 are also used with small d-c motors. A line of magnetic starters is available for use on d-c installations. On these controls, reduced torque and current are obtained by inserting a resistor in series with the motor. The resistor is automatically cut out in steps to accelerate the motor smoothly.

Control for Wound-Rotor Motors

For controlling wound-rotor motors, several standard devices are available. The most generally used consists of a magnetic starter such as that shown in Fig. 13, usually operated from a push-button station for opening and closing the primary power circuit, and a drum switch and resistor (similar to the one used on street cars) for controlling the secondary.

With the drum switch in the OFF position, all resistance is in the secondary circuit, as it should be for starting. When the START push-button is pressed the magnetic starter closes and energizes the motor primary. To accelerate the motor, the handle of the drum switch is turned, and successive steps of resistance are cut out. In the last position of the handle, all the secondary resistance is cut out, and the slip rings are short-circuited.

If full automatic control is desired, a magnetic starter can be supplied. This consists of a magnetic panel containing a line contactor and overload relay, a number of accelerating contactors, a timer for closing the accelerating contactors in a definite time sequence, and a push-button station.

To start the motor, the START button is pressed, the line contactor closes, and the secondary resistance is cut out

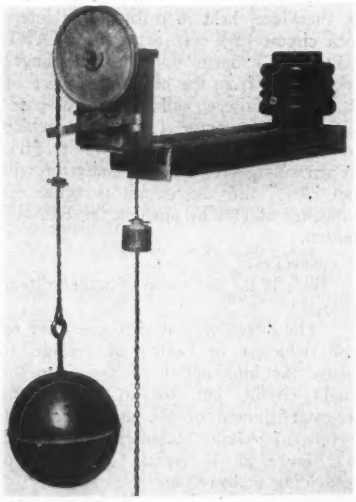

Fig. 26. Typical float switch

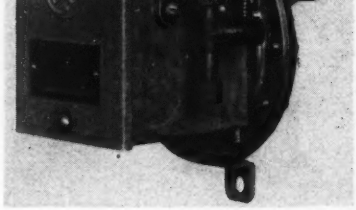

Fig. 27. Pressure switch with unloader valve and contact-opening attachments

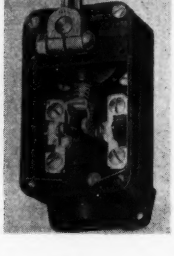

Fig. 28. Lever-type limit switch with cover removed

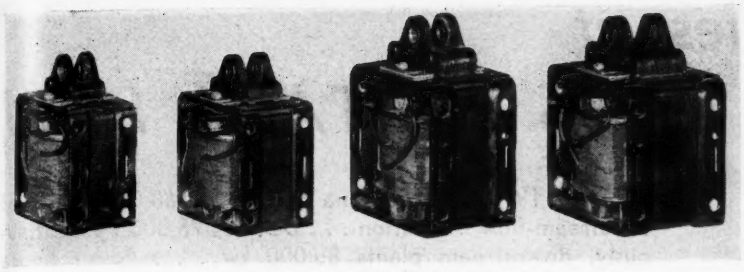

Fig. 29. Four sizes of pull-type solenoids

in a definite sequence and at a predetermined rate.

In these wound-rotor controls, we find all four basic parts: switching mechanisms, power-absorbing means, protective devices, and pilot-circuit devices.

Push-Button Stations

The majority of magnetic controls are operated from push-button stations, which are either mounted separately at a remote point or in the cover of the starter. Individual stations are available with from one to seven buttons (Figs. 24, 25) so that a series of operations can be controlled from one point. Push-buttons are generally of two classes: first, the momentary-contact type, and second, the maintained contact type.

With a momentary contact push-button, when the button is pressed a contact is made only as long as the finger depresses the button.

Fig. 30. Typical solenoid valve

All magnetic starters are equipped with an additional holding interlock so that momentary-contact push buttons can be used and undervoltage protection provided as explained previously.

A maintained contact button, when depressed, makes a circuit and maintains that circuit even when the finger is removed from the button. To open the contacts and stop the motor, the STOP button, which is adjacent to and mechanically interlocked with the START button, is pressed. This forces open contacts on the START button.

In addition to the operating buttons, push-button stations can be furnished with self-contained indicating lights in various colors. These indicating lights show when the motor is running at full or intermediate speeds, or indicate various other conditions of operation.

Push-button stations are ordinarily mounted on a wall or on the surface of the controlled machine, but they may be mounted flush with the surface of the machine frame or on a panel board.

Push-button stations for general-purpose application, where atmospheric conditions are normal, are usually housed in a sheet-metal enclosure. Stations in special enclosures that are dust- or watertight are available, as well as stations for installation in hazardous atmospheres.

Float Switches

The float switch shown in Fig. 26 is a device used to maintain predetermined high-or low-water levels in tanks or reservoirs into which water is discharged by motor-driven pumps. When the water level in the tank falls to a predetermined level, a control contact is made in the float switch, and the motor driving the pump is started. When the water level reaches a predetermined maximum, the contact in the float switch opens, and the pump is shut down.

By reversing the operating mechanism, the float switch can be used to empty a sump. These switches are available in single-, two-, and four-pole forms. A float switch can handle a small motor on its contacts, but generally the contacts are used to handle the control circuit of a magnetic starter. Various forms of mounting brackets are provided so that the float switch can be mounted on a horizontal plank lying across the top of the open water tank, or it can be hooked over the side of the tank at the top with a hook-on clamp. Either rod or chain operating switches are available.

Water levels in tanks or sumps can be maintained over a range of from two inches to many feet.

Pressure Switches

Pressure switches (Fig. 27) are similar to float switches but operate on pressure. They are ordinarily used for maintaining pressure between given limits in a closed tank. When the pressure falls to the minimum, the pressure on the switch diaphragm is reduced to a point where a set of contacts is made. This starts the compressor motor, and when the pressure reaches the maximum, the diaphragm in the switch opens the contacts and the compressor is shut down.

One of the most common applications of the pressure switch is on a garage compressor. This pressure switch may also be used to maintain water level in a closed tank by providing a certain amount of air within the tank, the pressure of which varies directly with the water level. Pressure switches can handle small motors directly, or the pressure switch contacts can be used to handle the control circuit of a magnetic starter.

Limit Switches

A limit switch (Fig. 28) is a contacting mechanism with either normally open or normally closed contacts. It is used to limit or indicate the travel of some moving part of a motor-driven machine or apparatus.

The most generally used is the so-called lever type in which the contacts are operated from a lever that extends out from the main part of the limit switch. On the end of this lever is a roller. The moving part of the machine comes in contact with the roller and moves it to such a position that the contacts in the limit switch are either open or closed. Some typical applications of a lever-type limit switches are at the top and the bottom of a dumb-waiter, skip hoist, motor-driven roller door, or motor-operated windows. If applied to a door; when the door reaches the extreme or open position, some part of the door comes in contact with the limit-switch roller; the limit-switch contacts are opened; this opens the control circuit to a magnetic controller; and the motor is stopped. In closing the door, the motor is started by means of the push-button in the reverse direction, and when the door reaches the closed position, a second limit switch is operated and the motor is stopped.

Solenoids

Solenoids (Fig. 29) are not a part of motor control as we commonly understand it, but many solenoids are included in industrial control devices. A solenoid consists of a stationary magnetic frame, coil, and a movable armature. When the coil is energized, the movable armature is attracted to the frame and causes the armature to move so that it completes the magnetic circuit. Through the solenoid, electrical energy is converted into straight-line motion. The solenoids are used to open and close valves, and on similar applications where a considerable pull with a minimum of travel is required.

Solenoids are available for operation on both a-c and d-c circuits, and are widely used throughout the machinery industry.

Electrically Operated Valves

Solenoid-operated valves (Fig. 30) are generally used throughout industry for controlling from a remote point the flow of liquids or gases. They are available in sizes from one-quarter inch up to 12 in., and for use in operating pressures up to 400 lb at temperatures up to 700 F. These valves may be either normally open or normally closed, and they are suitable for use directly on voltages up to 600, a-c or d-c.

They are usually operated from solenoids when the distance travelled by the valve stem in opening is relatively short, or on the small size valves where the pull is not too great.

Power Facilities at TVA'S FONTANA DAM

Latest of TVA dams, Fontana provides 1,160,000 acre-feet for stream-flow regulation . . . Delivers 75,000 kw continuously, downstream plants 85,000 kw . . . Power house contains two 75,000-kw Francis type units, provision for third unit . . . Details of turbines, governors, generators . . . Generation at 13,600 v; transmission at 161 kv . . . Details of forced-air-cooled 88,000 kva transformers, switchyard, controls . . . Station power, lubrication, auxiliaries

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FONTANA DAM, latest of the fourteen power dams built by Tennessee Valley Authority, will go into initial operation in January, 1945. The dam is located high in the Great Smoky Mountains on the Little Tennessee River, one of the principal tributaries of the Tennessee River. The initial power installation consists of two 75,000-kva vertical waterwheel driven units and the output will be delivered to the TVA power system over two 154-kv transmission lines. Provision is made for a third generating unit and additional lines.

From a drainage area of 1571 square miles, river flows at Fontana Dam site are estimated at 129,000 cfs maximum of record, about 3800 average and 420 minimum. The reservoir volume amounts to 1,450,000 acre-feet when filled to top of spillway and 290,000 acre-feet when at minimum expected reservoir level. This provides a controlled volume of 1,160,000 acre-feet for stream-flow regulation.

As a part of the integrated development of the entire Tennessee River and its tributaries, Fontana is situated with two privately owned and eight TVA-owned hydro plants below it, including Kentucky Dam near the mouth of the Tennessee River. In this strategic position, Fontana will increase the wartime dependable energy generated in the Tennessee Valley by about 1,400,000,000 kwhr during a dry year. Fontana itself will deliver about 75,000 continuous kw and the downstream plants about 85,000. During the low-flow portion of an average year, Fontana will deliver an average of about 125,000 kw, and the downstream plants about 115,000. In order to make fullest use of the flood storage and the potential energy resulting from Fontana, a cooperative agreement between the private owners and the TVA provides for the dispatching of water and energy by the TVA dispatchers who thus control the entire Tennessee Valley drainage area.

Turbines

The turbines are each of vertical Francis type, rated 91,500 hp at full gate under a net head of 330 ft at 150 rpm. They are designed to produce best efficiency when operating under a normal net head of approximately 360 ft. The gross head on the turbines varies from a maximum of 435 ft during the wet season to a minimum of 245 ft during late summer draw-down.

The turbines are connected to the forebay by steel-lined conduits approximately 400 ft long and 14 ft in diam, which terminate in a transition section reducing the conduit to 12 ft in diam for connecting to the turbine scroll case. The turbines are set with respect to tailwater so that the machines may be operated as synchronous condensers without the aid of a draft tube evacuation system. The draft tubes are of the elbow type with one vertical pier in the center of the horizontal leg. The upper portions of the draft tubes are lined with plate steel designed for bolting to the turbine discharge rings.

The embedded parts are all of conventional design and fabrication with the exception of the scroll case and the scroll case to speed ring connection. The scroll case is fabricated from plate steel having a maximum thickness of 1⅞ in., and the joints are all welded, including the connection to the cast-steel speed ring. All joints in the casing and speed ring were shop-welded with the exception of the joints necessary for shipping. The latter were field-welded by the manufacturer. Following the completion of the field erection of the scroll case, the completed casing and speed ring was

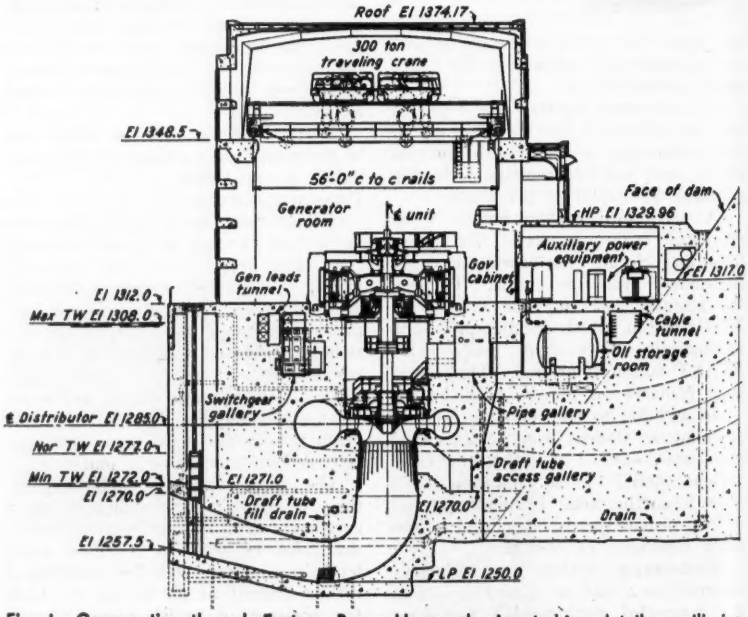

Fig. 1. Cross-section through Fontana Power House, showing turbine details, auxiliaries, switchgear and pipe galleries

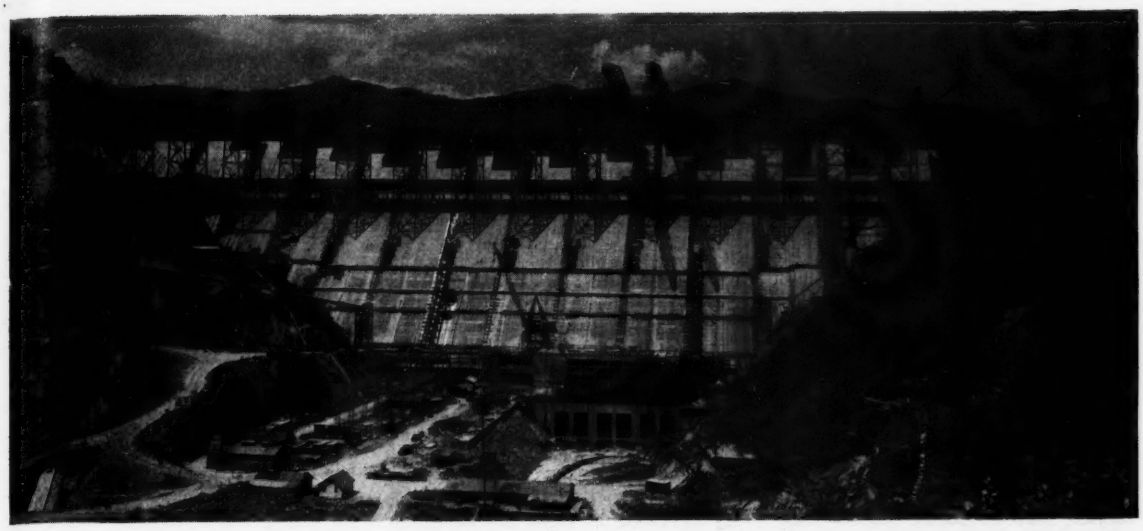

Fig. 2. General view of Fontana Dam under construction, showing power house, downstream face of dam, 470 ft high and 2300 ft long

subjected to a hydrostatic test of 371 psi. The scroll case is connected to the intake conduit by means of a filler piece and two riveted joints. The downstream joint is riveted prior to placing concrete around the turbine embedded parts. The upstream joint is left exposed and is not to be riveted until the surrounding concrete has reached a mean temperature of approximately 50 F.

Internal parts of the turbines are cast steel and of conventional design. Due to the critical shortage of noncorrosive metals and materials, stainless steel-clad facing plates were not used but the mating surfaces at the top and bottom of the wicket gates, the gate stems, and the contact surfaces of the gates themselves were chrome-plated to a thickness of 0.005 in. To stop all flow through the openings at the top and bottom of the gates, which might, due to the high velocities, cause erosion or scouring of the finished surfaces, the top and bottom facing plates are fitted with neoprene sealing strips, dovetailed into the plates and extending above the finished surfaces so that all flow is stopped when the gates are in the closed position.

The turbine guide bearings are oil-lubricated, with a stuffing box below the oil shedder. The main shaft bushing for the stuffing box is built up of stainless steel weld. The weld is approximately ⅛ in. thick when completed and polished. Each bearing is provided with an oil reservoir of approximately 100 gal which is connected to the station lubricating oil supply system. The bearings are lubricated under pressure from either an a-c or d-c motor-driven pump, and the arrangement is such that, upon failure of the a-c motor and pump to deliver the normal operating pressure to the bearing, the d-c pump automatically cuts in. If the d-c pump fails to deliver the required pressure, the turbine is automatically shut down and locked out until normal operating pressures are restored.

Adjustable, positive-acting, free air valves are provided in the head covers for admitting free air to the runners. There is also provided, but not connected, a system of piping for admitting free air into the draft tube directly below the runner. All the turbine parts that require greasing are fitted with high-pressure grease connections, serviced from a stationary barrel pump and high-pressure grease compressor located in the pipe gallery between the two units.

Governors

An actuator-type governor is provided for each turbine and is contained in an individual cabinet located on the main generator floor. The mechanism is mounted on a base formed by the oil sump tank, the capacity of which is sufficient to contain all the oil in the governor system. The capacity of each governor is sufficient to operate the turbine wicket gates through a full stroke, in either the opening or closing direction, in four seconds under any condition of load and head. Each governor is fitted with a high-pressure oil tank, which is located on the generator floor immediately behind the governor cabinet. The tank is connected to the governor oil pumps and the turbine servomotors by high-pressure piping with Van Stone flanges and long-radius fittings of sufficient size to hold the velocity of the oil flow to less than 18 fps. The relay mechanism between the turbine wicket gates and the governor mechanism consists of a series of rigid rods and bell cranks instead of the conventional cable and sheave arrangement.

Each governor is fitted with only one pump and motor. However, the oil supply system for both units is interconnected and arranged so that either pump may be used to maintain pressure in both pressure tanks, with the other pump automatically coming into operation should the oil pressure drop to a predetermined low. The normal operating pressure of the governing system is 300 psi. The initial pressure in the pressure tank is built up by means of a special air compressor designed to deliver 8 cfm against 300 lb. This pressure is then maintained by the governor oil pumps.

The unit controls and instruments are located on the face of the governor cabinet and are arranged so that the instruments are plainly visible to the operator when operating the gate and load limit controls. All the controls are operated from the governor board with the exception of the gate and load controls which can also be operated from the switchboard in the control room. Speed indication is provided on the actuator and at the switchboard. The governors are equipped with adjustable speed droop mechanism ranging from zero to six per cent. The power for driving the flyball motors is taken from potential transformers attached to the generator leads.

Generators

The generators are each rated 75,000 kva, 67,500 kw, 60 C rise, 13,800 v, and are built with standard type B insulation. The 60 C rating is matched with the turbine output at normal 330-ft net head and the inherent 86,250-kva continuous capacity at 80 C, allowable with the type B insulation, will not be exceeded at the 435-ft maximum head with the power factors expected. Operation will be at or near normal head for a majority of the time; this will assure conservative operating temperatures and long generator life.

Generator characteristics reflect normal design. Efficiencies are above 97 per cent. Short-circuit ratio is 1.1. Discontinuous damper windings are provided to promote stability and reduce voltage distortion with ground faults. Capacity as a condenser is 48,000 kva and capacity for line charging is 65,000 kva. Flywheel effect is 53,000,000 lb-ft^2. The total load on the thrust bearing including the rotating parts of the generator and turbine and the hydraulic thrust is 1,196,000 lb.

Construction is conventional, with Kingsbury-type thrust and guide bearings below the rotor, immersed in the same oil, and supported on a 6-arm radial bracket. The 275-kw main exciter and the 10-kw pilot exciter are mounted above the rotor and are partially telescoped so that the overhang above the bearing and the overall height are reduced to a minimum consistent with convenient access to the two commutators and the slip rings. The rotor and stator are enclosed and cooled by air circulation, heat exchangers, and water taken from the reservoir. Automatic CO_2 fire protection is piped to the housing.

Neutrals of the generators are grounded through individual breakers and 0.62-ohm reactors. Induction differential relays, connected in the full winding at the line end and half the winding at the neutral end, protect against phase-to-ground, phase-to-phase, and turn-to-turn faults, while an overcurrent relay, connected in the neutral ground lead, protects against ground faults near the neutral end and also serves as back-up for the differential relays.

Disconnects, instrument transformers, and surge protective equipment are enclosed in steel and aluminum cubicles near the generator terminals. The 15-kv main circuits to the transformers in the yard are carried in individual concrete tunnels below the generator floor and transformer platform for a distance averaging 265 ft. Each circuit is rated 3600-amp, 85 C copper, and consists of two 3½- by 3½- by ¼-in. copper angles per phase spaced to form a square with vertical ventilation. All joints are either brazed or silver-plated and bolted. The phases are arranged vertically on one wall of the tunnel and are separated from each other and from the walkway by solid barriers of ½-in. transite. The tunnels are ventilated as a part of the station ventilating system, the incoming air being cooled and dehumidified to facilitate heat transfer and to prevent condensation.

Transformers

Transformers are single phase with a bank rating at 55 C rise of 66,000 kva self-cooled, 88,000 kva forced-air-cooled. The ratings are so co-ordinated with the generator capacities that the fans are expected to operate at all loads in excess of about 88 per cent of the 60-deg generator rating, which will result in a conservative but economical transformer installation. The transformers are equipped with inert gas equipment. The neutrals of the 161-kv windings are grounded through an individual 43-ohm reactor for each bank. A single-phase, 145-kv arrestor is connected to the 161-kv terminal of each transformer. Induction differential relays protect against faults in the transformers and the 15-kv circuits from the generators.

Switchyard

The 161-kv switchyard is located on the right bank of the tailrace immediately downstream from the powerhouse. The initial installation consists of a 4-circuit ring bus with one breaker per circuit. The arrangement of equipment and structures permit expansion into a main-and-transfer bus scheme and, if necessary, into a double bus scheme without any material changes to structures or equipment. The breakers are pneumatically operated and rated 1200 amp, 2,500,000 kva, 50-cycle opening, 35-cycle reclosing. The lines are protected by carrier-current pilot relays with directional overcurrent ground back-up. After a trip-out, a line will reclose automatically at one end after automatic no-voltage check and then will be closed manually at the other end.

Disconnects are underhung, gang-operated. Those used merely for isolating the breakers, are manually operated locally and those later to be used for switching are electrically operated from the switchboard. Buses are of 4½-in. standard galvanized steel pipe, supported about 18 ft above ground on post-type insulators. Joints are welded and zinc-sprayed. Connections are of steel pipe, copper tubing, and copper cable as required. The structure is of galvanized steel with latticed members and with a central continuous ridge to which transformer connections and lines are terminated. Overhead ground wires coming in with the transmission lines are anchored to steel peaks atop the switchyard structure and extended into a protective ground shield over the yard and transformers.

Controls

The control room is located in the end of the powerhouse adjacent to the switchyard. It is air-conditioned and indirect-lighted from a single deep cove on the operator's side of the room and an unsymmetrical, arched, acoustically treated ceiling. The switchboards are of conventional TVA design consisting of a straight benchboard for controls, two back-to-back vertical boards for instruments and relays, a vertical recorder board at the operator's left, and a vertical battery board at his right. The usual controls and instrumentation for a large attended hydro station are provided. The steel boards are finished in a warm gray to carry out the room finish while all equipment has contrasting standard black finish. Terminals are located on wing panels behind the boards and the control cables pass through the floor to open transite cable trays in the room below. The cables, which are synthetic-rubber-insulated and jacketed, are distributed to the generators on trays through a cable tunnel and to the switchyard by ducts and manholes.

An operation recorder automatically records on a strip chart all equipment operations such as opening and closing of breakers, high temperatures of equipment, and stopping and starting of important auxiliaries, thus providing a continuous log of the station operation.

Carrier channels are provided on the transmission lines for communication with other stations and with the load dispatcher in Chattanooga for telemetering of certain loadings to the load dispatcher and for automatic load control. These are in addition to the channels required for line relaying.

Auxiliary Power Supply

Station service power supply is obtained from two 1000-kva transformers connected to the generator-transformer leads. Each has capacity sufficient for all essential auxiliaries with full station output.

A 125-kva, 480-v, 0.8-power factor generator driven by a 6-cylinder, 180-hp, 1200-rpm gasoline engine provides an emergency source to operate essential gates, valves, sump pumps and lighting, if all other sources are lost.

The three sources deliver to a main switchboard which distributes to three unit boards serving the essential auxiliaries of the three generating units and to a common board serving the lighting and heating and other auxiliaries which are not associated with the generating units. Two independent feeders are provided to each distribution board. The switching is so arranged that the output from the two normal supply transformers cannot be paralleled, and this arrangement permits the use of relatively light breakers. Any part of the power supply and distribution system up to but not including the unit buses can be retired for maintenance without loss of generation.

Turbine Lubrication

The lubricating oil system for the turbine guide bearings, the generator thrust bearings, and the governors consists of a clean oil tank, pump and piping, a dirty oil tank, pump and piping, and an oil purifier. All are interconnected to form a complete and closed system. The arrangement is such that either generating unit may be serviced with a complete filling of clean oil through clean lines from the clean oil storage tank or from the purifier, or the operation may be reversed and all of the oil in one unit may be dumped into the dirty oil tank through the dirty oil lines, or through the dirty oil lines to the purifier into the clean oil tank. The storage tanks are of sufficient capacities to contain all the oil for one unit. The oil purifier is a centrifugal type having a capacity of 350 gph.

Treated water at 75 psi is provided for drinking water and toilet facilities. Raw water from the forebay is provided for cooling and lubricating purposes and for station fire protection.

For ventilation of the powerhouse, air is supplied by fans to the generator room and is exhausted mechanically through the secondary rooms and spaces as required for the removal of heat and relief of damp or stagnant conditions.

The Fontana Dam was designed under the immediate supervision of George R. Rich, Chief Design Engineer for the TVA. When designs were initiated, the late Col. T. B. Parker was Chief Engineer. He was succeeded in June, 1943 by C. E. Blee.

Progress in STEAM ENGINEERING*

By C. B. CAMPBELL

Manager, Steam Engineering
Westinghouse Electric & Mfg. Co.

Steam turbine developments have improved reliability, thermal cycles, efficiency and individual unit capacity . . . Steam pressures and temperatures are dependent variables . . . Pressures in new installations of today are of the order of 650, 850 or 1250 psi . . . Steam temperatures are about 825, 900 and 950 . . . Blade deterioration indicates a limit of 12 per cent moisture in exhaust steam . . . Maximum speed of turbine blade tip is presently 1256 fps . . . Turbine speeds of 3600 rpm growing rapidly in acceptance . . . Blades 40 in. long are being used . . . Large machines have been designed for 1800 rpm, single cylinder, single exhaust flow for 75,000 to 100,000 kw rating . . . General agreement has been reached on turbine standardization . . . Possibilities of gas turbine are being investigated but these units are not yet of practical importance to public utilities

IN THEIR order of importance, recent and current turbine developments fall under one or more of the following general categories: (1) improvement of unit reliability; (2) adaptation to improved thermal cycles; (3) improvement of turbine efficiency itself, and, (4) greater concentration of power in an individual unit.

In general, we consider further improvement of the internal efficiency of the turbine itself to be secondary, in

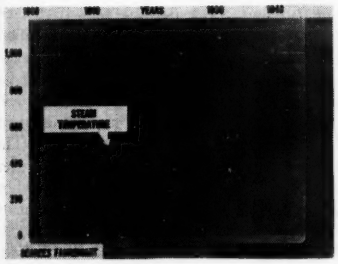

Fig. 1. Progress in throttle steam temperature and pressure of condensing turbines from 1900 to 1944

overall importance, to the adaptation of the turbine to economical service with more efficient thermal cycles. Large turbine Rankine cycle efficiencies are now close to practical upper limits, so we can reasonably assume further improvement along this line will be relatively small, and that substantial improvement may well prove to be unjustifiably costly. On the other hand, thermal cycle improvements have even recently led to materially lowered heat rates, and such development is still believed to be potentially the more promising.

It is helpful to consider probable steam conditions of the future in the light of their development in the past. For this purpose our first chart shows the advance of throttle steam pressure and temperature against time, for condensing turbines. We have intentionally omitted a single instance in which 2300 lb steam pressure was adopted, for the purpose of more clearly showing the broad trend. Present-day new installation steam pressures are generally of the order of 650, 850, or 1250 psi at the turbine throttle, with corresponding steam temperatures of about 825, 900, and 950 F respectively. The 850 psi class is currently the most common selection, with the 1250 psi class apparently gaining in popularity.

Increase of steam pressure, at a given temperature, tends to lower the Rankine cycle efficiency of the turbine, due to increased leakage loss in high pressure turbine stages and to greater moisture loss in the exhaust end blading. On the other hand, increase of steam temperature, at a given pressure, improves turbine efficiency by decreasing leakage and moisture losses. In spite of its adverse effect on turbine efficiency, increased steam pressure generally results in reduced heat rate of the turbine alone, as does, of course, increased steam temperature.

The potential gain in heat consumption with higher steam pressure is particularly important, however, when used with the regenerative feedwater heating cycle, as the limiting practical final feedwater temperature increases along with the steam pressure. The increment of potential gain in heat rate of the turbine and its feedwater heating system decreases sharply as the pressure level is raised; for instance, at constant temperature, the effect of steam pressure increase from 500 to 1000 psig is more than twice that available between 1000 and 1500 psig. Thus it becomes increasingly difficult to justify substantial pressure elevation over present upper levels. The reduction in heat rate due to temperature increase is, on the other hand, more nearly sustained at high levels, being of the order of 3 per cent per 100 F.

Steam pressures and temperatures may not properly be considered as independent variables. With the advent of large, high-speed exhaust blading, the problem of inlet edge erosion of such blades operating in wet steam was encountered. Experience has led to a general criterion that the exhaust steam moisture content should not exceed about 12 per cent, in order to limit last row blade deterioration to a reasonable economical level. We believe this limit is about right, even though a few entirely successful units have now operated for several years with somewhat higher exhaust moisture, and with present maximum blade tip speeds of 1256 fps. The exhaust moisture criterion really means, that, for a given exhaust pressure and turbine efficiency, and, for the moment excluding the reheat cycle, there is a fairly definite upper limit of pressure for any specific throttle steam temperature. For present-day large turbine efficiency levels, and with 1½ in. absolute exhaust pressure, this limit is about 600 psi at 800 F, 900 psi at 900 F, and 1500 psi at 1000 F total steam pressure.

Temperature Limitations

A far more important and realistic phase of the problem arises in determining how high it is practical to go in steam temperature without jeopardizing the plant investment through lowered availability. In this connection, consideration must be given not only to the turbine, but also to the boiler, superheater and auxiliaries.

From our existing experience at 950 F we believe that an exploratory increase to 1000 F is justified with present available and proved materials, but that experience at this advanced temperature level should then be thoroughly assimilated before venturing further. With 1000 F temperature, steam pressure could be advanced to about 1500 psi without obtaining excessive exhaust moisture. The potential reduction in heat rate at 1500

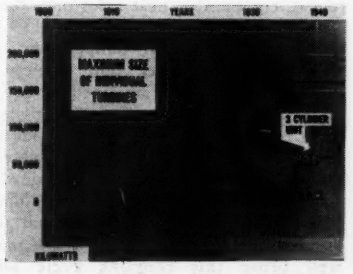

Fig. 2. Progress in ratings of condensing turbines from 1900 to 1944

*This article, which is an abstract of an address presented before members of the Prime Mover and Electrical Equipment Committees of the Edison Electric Institute, was one of four dealing with progress in engineering prepared and delivered by Westinghouse engineers. The occasion was a Power Engineering Conference arranged by Westinghouse and held in East Pittsburgh, Pa., October 4, 1944. The other papers presented were: Electric Power Generation, by C. M. Lafoon; Progress in Switchgear Engineering, by M. H. Hobbs; and Progress in Transformer Engineering, by J. K. Hodnette.

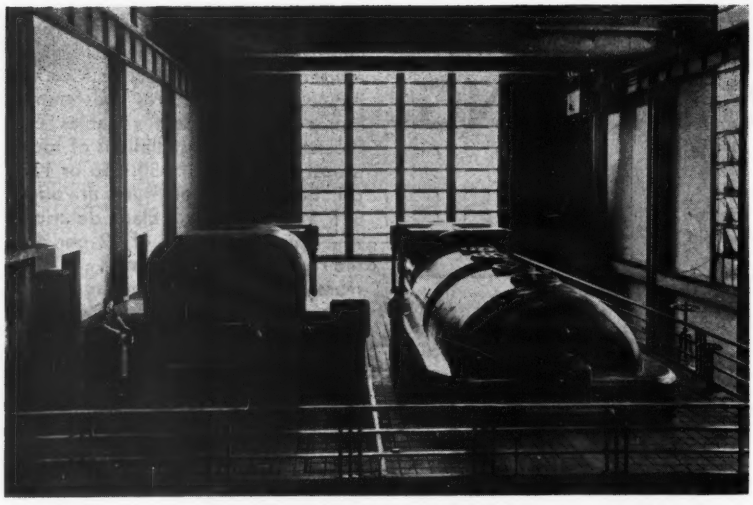

Fig. 3. 100,000 kw, 3600 rpm turbine installed in the Burlington Station of the Public Service Electric & Gas Co. of New Jersey

psi and 1000 F, as against 1250 psi at 950 F, is of the order of 3 per cent, the total gain being about equally due to the elevation of pressure and of temperature. Our suggestion is, however, that the initial step be taken in temperature increase only rather than to combine it with 20 per cent increase in pressure over the present 1250 psi level.

A coordinated, war-born program of metallurgical research on high temperature alloys is in progress. This effort is concerned primarily with alloys for use at temperatures far beyond those now contemplated for steam plants, and, in large part, for use in comparatively short lived equipment. Excellent materials have been developed for these purposes, but as yet they are available only in relatively small pieces, they are difficult to fabricate and they are very expensive.

In all of the foregoing we have considered future possibilities as they are related to high grade regenerative feed heating cycles, in accordance with general American practice, for which more or less standard turbines are now readily adapted. Since the maximum practical operating steam temperature is now such an obvious limitation, it is natural that alternatives be carefully considered. One such variation is the addition of immediate reheat to the multistage feed heating cycle. With a single stage of boiler reheat, comparable heat rates may thus be obtained with approximately 150 F reduction in top steam temperature, or something like 5 per cent reduction in heat rate may be obtained at equal upper steam temperatures. Investment charges, and operating considerations, have to date ruled this system out in all but very few installations in this country. The reheat cycle is mentioned here with the thought that increased fuel costs in the future may well bring this complex cycle into more frequent use, but then only with the higher unit ratings involving multiple turbine cylinders and with machine designs cut to special pattern for the individual installation.

Unit Capacities

Growth of individual condensing unit capacity is shown by the second chart. The recent rapid growth of 3600 rpm turbines is particularly important, since they have now taken over the bulk of the central station field; they have contributed materially to modern steam plant development, and they are likely to develop further in available rating.

As a general thing, the steam turbine is at best advantage when operating at the highest possible speed of rotation consistent with the provision of proper steam flow areas and area ratios throughout its bladed length. Under otherwise comparable conditions, increased speed reduces the physical size of the unit, particularly the diameter of the bladed portion.

The maximum economical rating of a condensing turbine is fixed, within limits of allowable leaving energy loss, by the area of the last blade row annulus, which is in turn limited by the permissible stress of both the blade and rotor materials. With large, exhaust stage blading, the major steady stresses are due to centrifugal force. It is essential, also, that these blade groups be so designed that their relatively low natural vibration frequencies shall not coincide with integral multipliers of possible excitation frequencies, that is, with multiples of rotating speed.

Condensing turbine exhaust blading is the least flexible element of the entire unit, since its manufacture involves the use of very expensive and special dies, tools and fixtures. Alterations are difficult, also, because of their critical effect upon blade vibration frequencies. It is approximately correct to say that the remainder of the turbine is therefore designed around an existing low pressure blade. Creation of new, large exhaust blading is undertaken as a major task. This we did in the mid 1930's, aiming for the largest blades which then seemed practical. This resulted in the development of 20 in. long blades to be carried on a 40 in. diam rotor for 3600 rpm, and of 40 in. long blades with an 80 in. base for 1800 rpm. Blade tip speed in each case is 1256 fps. The limiting single blade annulus for the lower speed unit currently has four times the area of the corresponding 3600 rpm turbine, meaning that it can accommodate substantially four times the steam flow, or rating, for a given last row blade efficiency.

Many of the higher speed units have now been in service upwards to 7 yr with the present limit blade. There has been some difficulty of a random nature which has led to detail modifications. Our experience, on the whole, indicates that when more urgent wartime activity is behind us we will be prepared to develop still larger blading, and larger condensing turbines, to drive two pole generators. So far as the 40 in. long blade at 1800 rpm is concerned, we have experience with but one turbine. We do not feel that there is any early future need for larger blading at this speed.

Accepted practice in this country has given a fairly definite pattern to condensing turbine generator arrangements in central station unit ratings. This has been promoted by a general preference for a single shaft unit, where practical, and by general agreement on the advantages offered at 3600 rpm; the latter consideration has, in some outstanding cases, been considered to predominate and to justify multishaft arrangements in preference to low speed single shaft units. To an increasing extent we find users selecting unit capacities on the basis of that available at the higher speed, using multiple exhaust turbines if necessary, to obtain the desired combined unit rating.

On the basis of condensing units capable of continuous output of 125 per cent rating, single cylinder, single exhaust flow turbines at 3600 rpm are available for ratings to and including 25,000 kw; by tandem compounding in two cylinders to provide double flow exhaust blading, unit ratings up to 65,000 kw have been obtained at the same speed. It is obvious that this same general plan of compounding could be carried further, and with three and four exhaust flow paths obtain correspondingly higher rating still with the single shaft design. Such construction however, has not as yet become common, one reason being that there has been comparatively little demand for unit ratings above 65,000 kw. Meantime, larger machines have generally been designed for 1800 rpm, using single cylinder, single exhaust flow for 75,000 to 100,000 kw rating, and tandem construction with double flow low pressure blading for still larger units. For extremes of steam pressure, and particularly of temperature, we feel that the low speed turbine might well be made multi-cylinder, even if within the volumetric limit of the single flow exhaust blading. We expect the higher

The PRACTICAL ENGINEER and ELECTRICIAN

ANDREW W. KRAMER, EDITOR

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An Idea for Laundry Engineers

Recently we came across an interesting method of drying clothes by refrigeration, recounted in the British Journal of The Institution of Heating and Ventilating Engineers. The person recommending the method reported that he had often washed and dried his own clothes that way, the clothes having actually been washed at 1 o'clock and dried, and ready to put on again by 5 o'clock the same day. The method was to quick freeze them at temperatures below zero F when all the water came out as crystals on the surface and could be removed simply by shaking. The very few traces of water or ice which remained were absorbed by the clothes in warming up to atmospheric temperature; there was no need for airing as the small amount was only equivalent to the hygroscopic regain. Since there is usually an ample supply of exhaust steam in laundries, it was suggested that this steam be used to run an absorption refrigeration system to produce the required low temperature for commercially drying clothes in this manner. Whether such a method would prove economical or whether it has any advantages over present methods of drying would have to be proved but it is a novel idea and might warrant some study. The drawback in the minds of laundry engineers when this method was described, was the possible damage to the fibers of clothing by sharp ice crystals. That might apply in the case of fine materials, but with low freezing temperatures, well below zero, it had been found no more harm was done than that usually resulting from calendering.

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A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 West Jackson Blvd., Chicago 4, Ill.

Twenty Years at Ponoka

Describing the rehabilitation of the power plant at the Ponoka, Provincial Mental Hospital in Alberta, Canada, over a period of 20 yr . . . Details of the boiler plant . . . The feedwater problem and its solution . . . Rebuilding the feed pumps . . . Drilling for water with a gas drill . . . Restoring the electric generating plant

By WILLIAM S. WHITE
Chief Engineer, Provincial Mental Hospital
Ponoka, Alberta, Canada

IT WOULD be impossible, unless one undertook to write a large book about it, to fully describe the evolution of a power plant of the type to be considered here, from a pile of junk or little better into a reliable, substantial asset, capable of all the service required of it and with sufficient reserve to meet any reasonable contingency. This, therefore, will be more or less of a rambling account, touching here and there on matters, it is hoped, will be of interest and, at the same time, by indirection, give a description of the plant so that it may be compared with others of similar type.

Articles appearing in current engineering magazines, always, or nearly always seem to be devoted to newly built plants, or plants that have been rebuilt in a short time. What about the thousand and one plants, that have been practically rebuilt over a long period of time by the efforts of the engineers in charge, and who received very little support in their efforts, and much less reward? There must be quite a number of engineers of such plants, who could write an interesting story.

It Was the Chief's Headache

When I first took charge of this plant in the year 1923, I found that it had passed through a series of growing pains, which instead of improving it, had left it in a state, best described as junkpile. Why this should have been the case, I do not know, unless it was, that the Government of the Province was passing through a series of growing pains itself. However, conditions being what they were, the authorities as then, absolved themselves of any responsibility in favour of the chief engineer, and left him to fight it out as best he could, though in no way permitted him to indulge in what they considered needless expenditures. Why I should have stayed to fight it out, when opportunity at the time was beckoning elsewhere, is still a profound mystery to me, as there is very little encouragement or reward in the public service.

At this plant, the boiler room had evidently been constructed to take care of two boilers of 125 hp, and these having been found too small owing to the expansion of the hospital, had been removed, and four 225 hp (based on 10 sq ft of heating surface) B&W straight watertube, single drum with a working pressure of 200 psi, crammed into the boiler room in double settings. These boilers were hand fired at the time, with natural draft provided by a handsome square brick chimney, 110 ft above the grates with an interior cross section of 16 sq ft. It was evident that height of the boilers above the grates was adjusted to suit the floor, and the girders of the steel trusses supporting the roof. At this point it is interesting to note that the consequent loss in furnace efficiency owing to lack of volume, would more than likely have provided the money to have enlarged the boiler room, and shown a nice profit to boot. The handling of coal and ashes was carried out by patients with wheelbarrows.

It will be seen, that it was a boiler room with bare essentials. The internal conditions of the boilers were found to be none too good, the tubes being thickly furred with a semi-hard scale. In the drums at the front end and near the bottom pitting had developed. The importance of efficient air removal from the returns discharged by the vacuum pumps, from the heating system had received no consideration. These pumps discharged directly into a small 200 hp open exhaust heater connected up dead end fashion on the branch from the engine exhaust stack to the header of the heating system, and the atmospheric valve being just above this branch. This exhaust heater is placed in a corner against the engine room wall, in the space between this wall and the back of the boiler settings, but owing to roof restrictions, the head above the feedpumps was only 13 ft.

As the most effective way of making sure that no air was being carried by the feedwater into the boilers, the suction pipe close to the feed pumps was changed, a tee being connected in, so that one branch led down into the pumps, and the other led upwards and vertical, a standpipe the same size as the suction, well above the level of the water in the heater, with an open end. This vent allowed the temperature of the feedwater to be carried much higher, and removed any entrained air. From the time this change was made, no further pitting developed in the boiler drums, and there has been none since. In passing, I may say this exhaust heater is still in use, and in the same place, although many good reasons have been advanced for a larger heater set up in a better position.

Boiler F.W. Heater supplied domestic hot water

On the floor of the space, between the back of the boiler settings and the engine room wall, were two small domestic hot water heating units, working on the instantaneous principle, no storage tank facilities being provided. These were badly scaled up, and too small in any case to provide the hot water required. To augment the supply of hot water for domestic use, someone had conceived the idea of pumping part of the feedwater from the exhaust heater, using motor driven centrifugal pumps, of which there were two, as the hot water system was under tower pressure. This meant that the boilers were being deprived of much good feedwater, how much would be hard to say, in the shape of condensate

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Here is a story that should make any conscientious engineer, if not sad, at least weary. It is the story of what the writer calls the rehabilitation of a power plant over a period of twenty years or more. It is said, the first twenty years are the hardest, and Mr. White no doubt will heartily agree with that saying. As he says in his article, why he stayed to fight it out when opportunity at the time was beckoning elsewhere, is still a mystery to him.

Mr. White's narrative makes interesting reading but we still wonder why such things should be. Why do conditions such as he describes have to exist in the power plant field? In view of all modern developments and the availability of efficient and reliable equipment, should capable engineers have to spend their lives nursing and patching up misfit equipment and antiquated systems? Why, when Mr. White requested a 20,000 gal water storage tank was he given one half that size? Didn't the brass hats believe him or did they think because he was an engineer he could make a 10,000 gal tank store 20,000 gal? We do not know the answers to these questions but we know that conditions such as Mr. White describes exist in innumerable plants throughout the country.

This is the first of two articles by Mr. White describing the rehabilitation, over a period of years, of this heating plant. A second article will cover other aspects of the work done and the results obtained.

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returns from the heating system, but the condition of the boiler tubes already referred to, suggested that it was plenty.

An immediate stop was put to this loss of good feedwater, by installing live steam jet mixers made of pipe fittings, to maintain the domestic hot water supply. This helped the boilers considerably, and when further condensate drainage was conserved from the laundry, kitchen, and other places, and returned to the boilers, a marked improvement in the internal condition of the boilers was brought about. In later years, when all practicable means had been applied to conserve and return condensate to the boilers as feedwater, and an evaporator made up from a scrapped section of boiler, and other material had been installed, and operated during the winter months, when live steam had to be used to supplement the exhaust steam for heating, it was found by the metering system also established, that the raw water makeup in one total year seldom exceeded 6 to 7 per cent. Another effect, that arose out of hunting for the ultimate drop of condensate, was the stopping of much useless steam wastage.

It will be understood that the application of live steam mixers was not a satisfactory and economical way of heating water for domestic use, when depending on conditions, varying amounts of exhaust steam were available for this purpose, and it was desirable to have the condensate produced by heating the water. Taking into consideration that approximately 50,000 imp. gals (metered) has to be supplied each day, and the most of it between the hours of 7 a. m. and 7 p. m. at the present time, and was not much less at the time I am dealing with, although it developed later there was a large variation in hot water use, owing to varying use of continuous baths in the hospital. A request was turned in to the proper authorities for two much larger heater units than the ones we had in use. It was pointed out that these preferably should be of a type from which the heads could be removed easily, and with tubes through which the water circulated to be heated, and these tubes large enough so that they could be easily descaled by a power driven cleaner. Instead of this type, two heaters were provided with ⅝-in. brass tubes, and these gave no end of trouble in trying to keep them clean. In the course of time, a water meter was procured, and with information derived from it, and a study and estimate of the varying amount of exhaust steam during non-heating periods, a request was made for the same type of hot water heating units as before, with separate storage tank capacity for 20 000 gal, but what was finally provided as heaters were exactly the opposite, and a storage capacity of 10,000 gal. The scaling trouble on the heating surface was now transferred from the inside of the tubes to the outside, and gave no end of trouble for some years. Finally a chemical treatment was discovered to stop the scaling action without affecting the water for general domestic use, but economically, the plant is still short the 10,000 gal of storage for hot water.

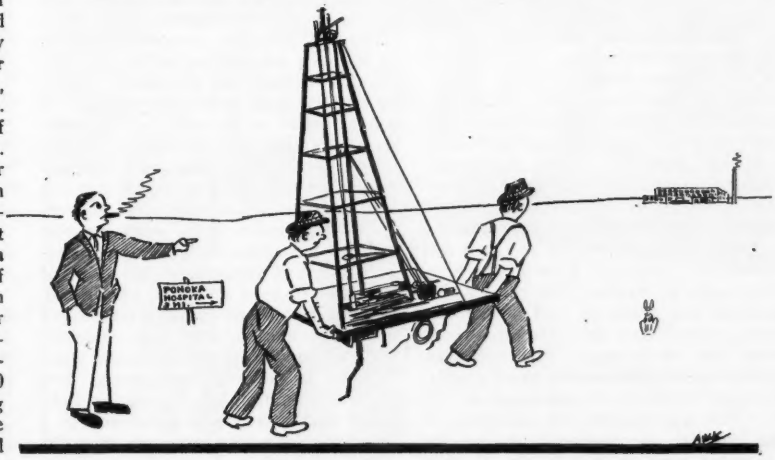
The plant passed through a siege of growing pains

It may be asked how the ⅝-in. tubes in the previous heaters were kept open and partially clean. This was accomplished by making up a special drill rod driven by a small electric motor; also a solution of muriatic acid was circulated back and forth through the tubes from and to a tank, by a small motor driven pump. By the exercise of time and patience, one heater was thoroughly cleaned, while the other was in operation.

Rehabilitating the Feed Pumps

Although there was plenty of floor space between the back of the boiler settings and the engine room wall, the two vertical single cylinder marine type feed pumps had been installed as close as possible to the wall, and were in such a position that they could not be observed by either the engineer or fireman unless they happened to be in this particular area. These pumps were decidedly undersize, and had to be run at too high a piston speed for good operation. At the time I took over there was only one of the feed pumps capable of functioning, the other one was dismantled with parts scattered all around it. With a large injector retrieved from disuse, and fixed up, to act as a standby for pump that was still able to operate, we completely rebuilt first one idle pump and then the other one.

With only the semblance of a machine shop, in the shape of a small 6 in. by 6 ft lathe, which had suffered a lot of abuse, the badly scored piston rod, after some patience, was turned down to a smooth job, the gland bores babbitted, and bored out to fit the smaller diameter of the rod. The bronze liner of the water barrel was in terrible shape, and when it had been about decided to increase the size of the bronze water bucket or piston by grub screwing brass strips around the diameter, luckily enough a new liner was discovered in a corner among other material, which had apparently been ordered and forgotten. By blocking up the lathe head, this liner was turned down to a fit, put in the brine tank to cool, the water cylinder of the pump heated up by steam, and the liner dropped into place so that the ports matched exactly. The removable valve decks with badly cut valve seats were refaced, and valve disks made from discarded valve disks from the vacuum pumps. The steam cylinder and piston rings, though much worn was still in serviceable condition. The valve mechanism, however, was not so good, and the steam actuated piston, that moved the slide valve, had to have rings fitted to it to make steam tight enough to do the job. The pilot valve had to be refitted to its seat. In estimating what was done, it is to be remembered, at this time, outside facilities were lacking, and repair parts for the pumps had to come all the way from Great Britain, and some reliability in feeding the boilers was required right away. In due time the pumps were put into first class shape, and although a new and larger pump was asked for, owing to the ever increasing load, it was only after a good many years that a larger and more suitable pump was provided, equal to the capacity of the two old feed pumps.



The Chief told them to move the rig to the hospital and drill for water

Troubles with the Water Supply

Another pressing matter I found at the start was the water supply for the hospital and plant. This was derived from two deep wells, which pumped into a reservoir, and from this it was pumped to a 80,000 gal tower, which maintained a pressure of 70 lb on the water distributing system. The pumps used for the deep wells consisted of a Marsh steam cylinder placed vertically over the well, and connected by sucker rods to a single acting pump barrel 120 ft below. Both pumps had to be operated at a much greater speed than they were capable of, and breakage of the sucker rods called for repairs at all hours, in order to maintain the water supply. The chronic shortage of water also provided a constant source of friction between those who used the water and those responsible for providing it. Hospitals of this kind require an unlimited supply of water, both cold and hot. In a fairly successful effort to keep the deep well pumps on the job (I say this, because the better the water supply, the more water was used), the knuckle type sucker rods, made up with wood lengths, were replaced with extra heavy 1½-in. pipe lengths screwed together with extra heavy hydraulic couplings. This change reduced considerably the time previously lost in repairs, and allowed some storage to be maintained in the reservoir, although this had to be guarded jealously in case of fire. Various attempts were made to augment the water supply, by drilling further deep wells at various spots by the use of a portable drilling rig, without any further supply of water being obtained. In the meantime, for some reason or other, someone connected with the organization decided to try and reopen a well which had been drilled for gas, some distance away from the hospital, and which had been left with the standard drilling rig and equipment in position as it was when shut down.

No Gas but Plenty of Water

For a year or more, while the water problem was giving plenty of trouble, the rig was being operated by a drilling crew, in an attempt to discover a supply of gas. Finally word came that the drilling rig was to be shut down, and the crew discharged, as apparently no results were being obtained. As it would be some time before those responsible would find out, the chief engineer, who as happened on this occasion, had been selected to notify the driller to shut down, changed the message to suit his own purpose, and instructed the drill crew to move the rig to a site near the hospital and drill for water. By bringing to bear all the help that could be drafted, the rig was in position and ready to drill before the ones in the higher brackets discovered what had taken place. The well was drilled in any case, and a good supply of water struck in the sandrock at 160 ft. This well proved the salvation of the hospital, as apparently the supply of water was unlimited. An electric motor driven, double-acting deep well pump was installed at this well, and it was able to maintain a steady flow of water at the rate of 125 imp. gal per min. The sequel to this was the expansion of the hospital facilities in new buildings by 30 per cent two years later. The chief often wonders what would have happened if it had been a dry hole.

With the addition of the new buildings, sufficient pressure was brought to bear to have a duplicate drilled a short distance away from this well, and equipped in a similar manner. The water from these new wells proved to be much better than the water from the old wells, and these were discarded. On the economy side a large saving in steam consumption was effected along with less repairs and maintenance where water was concerned. As a great deal has been said about the water, and its tendency to scale, it might be inferred that it was a difficult water in many respects, but such is not the case. It is a particularly good type of water for domestic purposes, showing only 10 to 12 grains of hardness, and this is easily treated as far as softness is concerned. Once conditioning of the water in the boilers was understood, brought about, and maintained, by establishing a suitable density, no further boiler cleaning was needed. The power tube cleaner is now put through the tubes to clean off the fire side of the tubes, as the boilers have clean surfaces inside all the time.

The Lights Went Out

On the third day of my service at this plant, the only direct current generating unit capable of operating had to shut down owing to loss of oil pressure on the bearings, in turn due to a faulty union repair that had been made on the internal oil pipe system in the crankcase of the engine, a vertical compound Belliss Morcom engine with opposed cranks, driving directly connected, a 125 kw, a 250 v three-wire generator. This left the hospital without power or light for two hours, as the other generating unit of a similar type and capacity, but with another make of engine running at a little better than half the revolutions and designed to run on a lower steam pressure, was partially dismantled owing to a heavy hammering which had developed during its operation. After service had been restored by making a proper repair on the oil pipe, the matter of getting the dismantled engine into some sort of running condition was gone into. It was found that the low pressure piston rings were broken, and the cylinder worn away on one side by the action of a cast steel umbrella type of piston, and that this had been caused by a set in the piston rod. The high pressure cylinder was found in fair condition, but had evidently suffered conditions similar to the other cylinder at some previous time. The general condition of the engine indicated that it had been subjected to a great deal of water carryover with the steam, and while it was fitted with a separator close to the throttle, this had been provided with a trap that was not at all suitable for this purpose. To expedite matters and to get somewhere, it was decided to run the engine on the high pressure cylinder, with the piston left out of the low pressure cylinder, but with the rod left in place. This worked out very well as the boiler pressure was higher than that required at the throttle of this engine. In the course of time this engine was put into a reliable state of repair, but owing to its high steam rate, became more or less a standby unit governed by conditions. Eventually it was possible to give the Belliss engine a complete overhaul. This engine was a newer engine than the one lastly referred to, and was not of course in such bad shape as it might have been.

Describing how the engine crankpins were turned up in place without removing the crankshaft from the engine, will give a very good idea of what had to be done to put the whole engine in shape. These pins were badly worn and grooved and it was impossible to fit the brasses to them, and have a decent job. To true them up, duplicates of the bearing halves were made of hardwood blocks, bored to fit tightly around the crankpin. On the division of one half a recess was cut next to the pin, to carry a cutting tool, with its edge extending fully across the crankpin, and rounded at the corners to suit the fillets at the webs. Backing was given to this tool by adjusting screws threaded into a thrust plate fastened on the sides of the wooden substitute brasses, the screws extending through the holes to contact the back of the cutting tool. With this arrangement bolted in place to the connecting rod, and turning the engine over with the starting bar, both crankpins were successfully trued up. Another a-c generating unit which was a 125 kva, 2200 v, geared turbine setup, completed the generating capacity as I found it at first. In the course of time the turbine unit was removed, for while it was suitable enough for lighting purposes in the local small town, and taking care of a few small motors, as larger and heavier motors were hooked on, it did not respond quickly enough to the heavy demand, and was always in constant danger of stripping the gears. It is interesting to note that when this turbine was removed, the exhaust, which passed through the concrete foundation, had been installed a size smaller than the turbine called for. In an offset of the engine room, towards the brick chimney, a walled in basement had been sunk, and in this some genius had installed three wet vacuum pumps to take care of the heating system.

Editor's Note: This is the first of two articles by Mr. White. A second article to be presented in a subsequent issue will finish the first stage of general condition and description and remedies; describe the intermediate stage, when the plant had some more growing pains; caustic embrittlement of the boiler drums and the results; and finally the last stage, the economic setup and the results.

Low and High-Temperature Spark Plugs

"THE four-cylinder motor I recently purchased runs perfectly on kerosene or tractor fuel at reasonably high speeds and temperatures with a fair load; but when I shift to a constant light load, with a consequent reduction in speed and temperature, it seems that the plugs become foul, or something happens, and it starts missing on one or two (sometimes more) cylinders. What causes this? Sanding (or cleaning) the plugs relieves this trouble only temporarily," remarked an unexperienced operator to a more or less skilled engineer.

"Your motor," replied the engineer, "is equipped with high-temperature plugs, intended for use at speeds and loads corresponding to the type and horsepower of that particular motor, and of course suitable for the temperatures produced by such loads and speeds. A cold motor of that type must always be started on gasoline and warmed up before shifting to kerosene or tractor fuel; and even then if the speed is not sufficient to produce a high enough temperature, the plugs become foul after shifting to the cheaper fuel in the case of high-temperature plugs, causing shortage of the current, and the resulting missing cylinders."

"What can I do to correct this trouble —if anything?" the operator asked further.

"You can purchase low-temperature plugs," said the engineer, "and put your motor in shape for operating at low speeds and the consequential low temperatures. You can take this matter up with your service man at the branch house where you purchased your motor; or if he is unable to serve you, you can probably obtain the desired type of plugs directly from the factory, after explaining your predicament by letter."

Unusual Electrical Troubles

By J. R. Kennedy

A ONE-CYCLE, one-cylinder, magneto-equipped gas engine in a power plant began firing irregularly, sometimes backfiring or refusing to fire at all. When it first started giving trouble, it would run fairly well for a short time and then it would perhaps miss and fire alternately until it came to a dead standstill. The igniter was suspected as being the cause of the trouble. At first it appeared one of the igniter springs was too strong to permit the other spring to force the igniter points together under the impetus of the igniter push rod. This was checked and found to be untrue. When it had been definitely determined that the igniter springs were properly balanced and of proper strength, it was suspected that heat expansion in the igniter base interfered with the free movement of the "moving" igniter rod; but the trouble continued even after the moving parts had been filed down to provide free movement even after heat expansion.

To check the trouble further, the piston was removed from the engine and it was turned forward as in starting. By looking into the cylinder as the engine was turned over and over, it was determined that the igniter was firing, but very irregularly; and often at the wrong time, in spite of the fact that all "timing" gears were properly meshed according to marks provided by the manufacturer. Since it was now evident that the igniter points were going together and breaking during each revolution of the engine, it was evident that the trouble was in the magneto, which evidently was not worn out, as there apparently was no looseness from the outside.

Upon disassembling the magneto, it was found that a brass "ring" on the discharge end of the armature of the magneto, had become loose and disconnected from the "discharge" wires of the armature. The ring was floating or turning haphazardly on the armature, causing alternate connection and disconnection. This accounted for the erratic firing. The trouble was permanently corrected by wedging the ring tightly in position, and by carefully soldering the loose wire in position in a notch provided in the ring.

Resin-Core Vs. Acid-Core Solder

An engineer at a natural gas station had considerable trouble with two eight-cylinder, 800 hp gas engines due to missing cylinders caused by shorts resulting from corroded electrical connections. Corrosion "shorts" often caused half of the cylinders to miss, and the result was that gas from the missing cylinders was forced or discharged into the exhaust muffler while trying to start the engines by means of compressed air. When the "firing" cylinders did start hitting, the result was often a war-like explosion in the muffler when the "exhausted" gas was ignited.

The troublesome corrosion referred to above was greatly decreased by using resin-core instead of acid-core solder in soldering the "jumper" connections on the engines referred to. Without going into the chemistry of this matter, it may be stated with confidence that much corrosion of electrical connections can be avoided, or greatly decreased, by solder. Acid is an aggressive trouble-substituting resin-core for acid-core maker, while resin is mild mannered.

"Yes, we do need men badly on these Diesels—but I'm afraid your motor experience on a Model T won't do much good."

The Boiler Fireman's Handbook

By J. R. DARNELL

IV Interpreting Flue Gas Analyses

Checking mistakes in analyzing samples. . . . Calculation of CO in case of weak absorption solutions. . . . Use of diagram in checking analyses. . . . The Hydroxylation Theory—Calculations for incomplete combustion with hydrogen or hydrocarbons. . . . Use of special types of Orsats for determination of other gases

ALTHOUGH A FIREMAN has learned how to take flue gas samples correctly and has mastered the technique of analyzing these samples, the results will be of no value to him unless he understands the meaning of his recorded percentages of CO_2, O_2 and CO.

Sometimes even the most skilled operator inadvertently makes mistakes in analyzing flue gas samples. Such occasional errors are excusable and are of no consequence if the analyst is trained to detect discrepancies in recorded figures for particular types of fuels when compared with calculated figures showing what the actual results should be.

As was shown in Table 1, Chapter I,* for every fuel there is maximum theoretical percentage of CO_2 which can be accurately calculated if the ultimate analysis of the fuel is known. This value of CO_2 is the basis for checking the accuracy of observed values of samples of flue gas. The maximum theoretical CO_2 may be calculated by the following formula, if an ultimate analysis of any solid or liquid fuel is given:

$$M = \frac{21}{\dfrac{1 + [2.38\,(H - O/8)]}{C + 0.4\,S}}$$

Where C, H, O and S are the percentages respectively of carbon, hydrogen, oxygen and sulphur in the ultimate analysis, as fired. However, if no ultimate analysis is available, the fireman can calculate the maximum theoretical CO_2 if he is reasonably sure that his oxygen determination is correct.

A. A. Bato[1] has developed some simple formulas and charts which enable the operator to speedily check his flue gas analysis for conditions both when combustion is complete and when it is incomplete. Equation 1 is to be used for calculations when combustion is complete and No. 2 for incomplete combustion due to the presence of CO, but no hydrogen. Equation 3 for determining the oxygen value has been developed by the author from equation 1 which was taken from the Bato article. Equation 4 is to be used to calculate the percentage of excess air. Maximum CO_2 is M, actual CO_2 in the flue gas sample is k, CO is km and per cent excess air is E:

$$M = \frac{21k}{21 - O_2} \qquad (1)$$

$$M = \frac{21\,(k + km)}{21 - O_2 + 0.395\,km} \qquad (2)$$

$$O_2 = \frac{21\,(M - k)}{M} \qquad (3)$$

$$E = \frac{(M - k)\,0.79}{k\,(100 - M)} \qquad (4)$$

Equations 5 and 6 have been developed by the author from equation 2, for calculating oxygen and carbon monoxide respectively when combustion is incomplete as to the formation of CO but when there is no hydrogen or other gases containing hydrogen such as methane (CH_4) ethylene (C_2H_4) or possibly, in rare instances, formaldehyde (CHOH):

$$O_2 = (21 + 0.395\,km) - \frac{21\,(k + km)}{M} \qquad (5)$$

$$CO = \frac{21 - \left(O_2 + \dfrac{21k}{M}\right)}{0.395 - \dfrac{21}{M}} \qquad (6)$$

As an example, in calculating for CO, if the maximum CO_2 (M) is 12.2 per cent, the actual CO_2 (k) is 10.0 per cent and the oxygen is 2.8 per cent, then substituting these values in equation 6, we obtain a figure of 0.74 per cent as the value of CO.

Calculating the value of CO is often advisable if the operator suspects that his solution for CO absorption is almost spent or if he should happen to lose the sample after making the oxygen determination.

For convenience of firemen who do not always have time to make calculations, if the combustion is complete the diagram devised by Mr. Bato and shown on page 120 may be used to check the accuracy of the flue gas analysis and also to determine the amount of excess air for any given value of CO_2. The sum of CO_2 and O_2 is shown on the vertical scale at the left, the actual CO_2 on the horizontal scale at the top of the diagram, and the values for varying percentages of excess air by the diagonal lines extending out at the top on the horizontal scale, while the values for maximum CO_2 are shown by the family of diagonal lines which begin at the upper left of the diagram and branch out diagonally to the right. As an example of the use of this diagram, let us assume oil firing with a maximum theoretical CO_2 of 16.0 per cent and the actual CO_2 as 12.0 percent as determined by the Orsat. Then, starting on the broken vertical line for 12 per cent CO_2 we move downward until we intersect the diagonal line for 16 per cent maximum CO_2 and then proceed horizontally to the left hand vertical scale for the sum of CO_2 plus O_2. This gives us a value of 17.2 per cent. If our Orsat reading had previously given us a value of 5.2 per cent for oxygen, this shows that our analysis was correct. If, however, we had obtained only 4.5 per cent oxygen in the Orsat the reading on the diagram shows that either we must not have extracted all of the oxygen or else our value for maximum CO_2 is in error.

As previously mentioned, we may also use the diagram to determine excess air values or check calculations. Going back to the intersection of the lines for maximum and actual CO_2 values and reading diagonally upward to the right on the broken line, we see that our CO_2 value of 12 per cent is equivalent to a figure somewhat greater than 0.3 or 30 per cent excess air. Checking with equation 4 and substituting the values for maximum and actual CO_2 we obtain the following:

$$E = \frac{(16 - 12) \times 0.79}{12\,(100 - 16)} = 31.3 \text{ per cent}$$

For coal firing, where the maximum theoretical CO_2 is, for example, 18.5

*August 1944 Issue, p. 86.

per cent and the actual CO_2 in a particular sample happens to be 10.0 per cent, if combustion is complete, we find by referring again to the diagram on page 120, that the oxygen should be 19.6 — 10.0 or 9.6 per cent. If the Orsat reading shows only 9.0 per cent, it indicates that there has been some error in the analysis.

The Hydroxylation Theory—Calculations for incomplete combustion with hydrogen or hydrocarbons

As mentioned above, incomplete combustion does not always result in the burning of carbon and hydrocarbons to CO and water vapor since there may be occasions when a careful check of the Orsat analysis indicates that there is incomplete combustion *even though there is no CO found in the sample.* Such analysis, however, is seldom or ever found under the conditions existing with modern designs of boiler furnaces where there is sufficiency of air supply with complete mixing and high temperature. In the few cases where such peculiar conditions of incomplete combustion have been observed, gas was burned under boilers with small combustion space, with improper air mixing and with low furnace temperature. Under such conditions we obtain practically the same effect as when a gas flame is kept too high under a tea kettle which has just been filled with cold water. Under such conditions there often is the peculiar odor of formaldehyde. Dennis[2] says:

"* * * None who has had material experience with gas-fired furnaces has failed to observe that when insufficient air is admitted for complete combustion a characteristic pungent odor will be distinctly noticed. We have often heard it referred to by firemen, by their remark, 'I smell CO.' This statement comes from their knowledge that when this odor is present the flue gas samples invariably show the presence of CO, which is well known to be an odorless gas. This odor is the characteristic odor of an aldehyde and any high school chemist recognizes that the odor of aldehyde is one of their characteristics which is unfailing in identification. * * *"

Reed[3], on the other hand, states that in all the cases of incomplete combustion with gas firing which he has observed he has never found any CO in detectable quantities although he too states that the odor of formaldehyde was noticeable.

Regardless of whether or not CO is present in cases where the presence of other gases gives evidence of incomplete combustion, the theory which attempts to explain the presence of formaldehyde and other related compounds is called the hydroxylation theory. We will not attempt to discuss this in detail but if any reader is interested he may find several references to literature on this subject, in an article written by the author[4] a few years ago.

Bato[1] explains the difference in the relationship between actual and maximum CO_2 when incomplete combustion is observed by the presence of CO and hydroxyl compounds as compared to the presence of hydrogen and hydrocarbon gases. The presence of unburned CO or formaldehyde and other related hydroxyl compounds in a sample of flue gas lowers the CO_2 which should be obtained while the presence of hydrogen and hydrocarbon gases raises the CO_2 value. In the example given in the diagram on page 120 where the maximum CO_2 is 16.0 per cent when burning fuel oil, if all of the hydrogen were to escape unburned, the maximum CO_2 would be 18.03 per cent. Bato gives the analysis of this oil as: $C + 0.37S = 85$ per cent and $H - 0/8 =$ 11 per cent. In the case of coal firing with a normal maximum CO^2 of 18.5 per cent, if all the hydrogen escaped unburned the maximum CO_2 would be 19.5 per cent or if the hydrogen were combined with the carbon in the form of ethylene (C_2H_4), the flue gas could contain 1.43 per cent CO and 1.32 per cent C_2H_4 without changing the maximum CO_2 value of 18.5 per cent. This may be calculated by the formula:

$$M = \frac{21\ (k + km + C_2H_4)}{21 - O_2 + 0.395km + 1.94\ C_2H_4} \qquad (7)$$

It should be understood, of course, that for the analysis of samples which indicate incomplete combustion beyond the determination of CO, the operator will find the ordinary Orsat apparatus, as described in Chapter III,† inadequate. Where such conditions exist, a mercury Orsat with an extra pipette for the determination of unsaturated hydrocarbons such as ethylene and a combustion pipette for determining methane and hydrogen, should be used. Such apparatus is completely described in United States Bureau of Mines Bulletin 197, "Sampling and Extermination of Mine Gasses and Natural Gas."

In plants where a mixture of different fuels is sometimes burned, firemen may be interested in a new combustion control method suggested by Reed[3] who has observed that the O_2–excess air relationship is independent of the CO_2 concentration of the flue gases. He suggests that firemen control combustion by determination of the percentage of oxygen in the flue gas instead of the CO_2. As an example, he cites the case where conditions may require a change from normal gas firing to a combination of 75 per cent oil and 25 per cent gas. With gas firing under CO_2 control, the excess air is kept at 10 per cent but if oil is burned it will require 15 per cent excess air. Under such conditions Reed says that "only a mathematical wizard could tell the operator in anything like a reasonable time what CO_2 indication he should have and hold to maintain efficiency". He then points out that although there is a wide variation in the curves of CO_2—excess air relationship for different types of fuels, the O_2—excess air relationship is practically the same for all fuels, particularly in the range of good operation, say from 10 to 30 per cent excess air. For example, when firing coke which has a maximum CO_2 of about 20 per cent, the CO_2 with 20 per cent excess air is about 16.7 per cent. When firing natural gas having a maximum CO_2 of about 11.5 per cent, the CO_2 with 20 per cent excess air is about 9.5 per cent. On the other hand, with 20 per cent excess air for either of these fuels, the percentage of O_2 in the flue gas is practically the same. The following tabulation, taken from Mr. Reed's curves shows, at a glance, the striking difference between the CO_2 and O_2 relationships with 20 per cent excess air for all fuels:

	Max. CO_2	Actual CO_2	Actual O_2
Coke	20.1	16.7	3.8
Anthracite	20.1	16.7	3.8
Bituminous coal	18.9	15.6	3.7
Oil	15.4	12.7	3.7
Refinery Gas ...	13.3	11.0	3.6
Natural Gas ...	11.5	9.5	3.6

The disadvantage of controlling combustion by O_2 determination instead of CO_2, where only one fuel is fired, would be that slight variations in oxygen values make considerable difference in excess air values. These slight variations in O_2 might not be detected unless all interrelated equipment is kept extremely sensitive. For example, with gas firing at 3.6 per cent O_2 and 20 per cent excess air, if the O_2 increases by only 6/10 of 1 per cent, that is, to 4.2 per cent, the excess air goes up to 25 per cent.

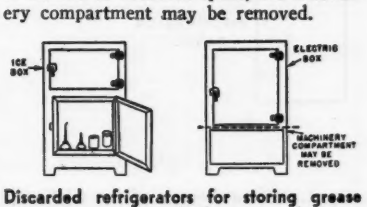
† October issue, p 102.

1 A. B. Bato—Flue Gas Computations—Mechanical Engineering, Vol 48, April, 1926, pp 328-336.
2 E. L. Dennis — New Developments in Burners and Their Application—Refiner and Natural Gasoline Manufacturer, Vol 18, Oct., 1939, pp 87-96.
3 R. Reed—New Combustion Control Methods for All Standard Fuels—A.S.M.E. Transactions, Vol 66, July 1944, pp 407-12.
4 J. R. Darnell—Can the Hydroxylation Theory of Combustion Be Applied to Modern Furnaces? — Refiner and Natural Gasoline Manufacturer, Vol 19, Feb., 1940, pp 65-66.

Keeping Lubricants Dustfree

By Thomas Trail

KEEPING OILERS and containers of oil and grease in a small discarded refrigerator will keep them free of dust and lint. An ice type refrigerator is preferable since it provides more usable space, but the food compartment of an electric box is satisfactory. In the latter case, if desired to conserve space, the machinery compartment may be removed.



Discarded refrigerators for storing grease and oil

How Would You Do It?

Problem 36. The Capacitor Problem

ENGINEERING is supposed to be one of the exact sciences. While we have not the slightest doubt that it is, it always seems curious that so much difference of opinion can exist on the correct solution of problems that, offhand, appear to be quite simple. We were reminded of this fact this month in our attempts to evaluate the merits of the various solutions sent in by the contestants who participated in the solution of the Capacitor Problem presented in the September issue.

Fundamentally, this problem is quite simple. It involves nothing more than the design of an arrangement which will automatically switch in or out banks of capacitors when the electrical load on the circuits increases or decreases. As might be expected, there are several ways in which this may be accomplished but the question is, is there one best way? By this, we do not mean, details of switches or contactors or anything relating to the actual wiring arrangement. What we do mean, is whether the control should be obtained from variation in load or voltage, or phase angle or what? We know from the statement of the problem that the loads on the circuits vary. This, then, offers one method of control; we can place some sort of load controlled relay in the circuit to automatically connect or disconnect the capacitors when critical conditions are reached. However, from the very fact that capacitors are installed to correct power factor, we know also that the power factor varies, and, if this is so, then the voltage of the circuits, also, must change. In other words, there are three variables. Which one should we use as the controlling force?

In raising this question we are not necessarily implying that use could not be made of any of these three variables but it is reasonable to assume that one of them might be best. No doubt, this is true but electrical men do not seem to be at all agreed upon that point. Among the many who sent in solutions to Problem 36, some used the voltage variation, others the power factor variation but the majority preferred methods of control which used load or current variation as the actuating force.

Opinion was also divided as to whether the capacitors should be cut in and out of the circuit automatically or whether they should be cut in and out manually as a consequence of a visual or audible warning system. It seems to us that as long as one has gone to the trouble of devising a warning system it is only logical to carry the procedure a step further and make the system fully automatic.

In awarding the prizes, we have endeavored to be fair, but it must be admitted that there was some doubt in our minds as to whether the first prize award should go to a contestant using the power factor itself as the actuating force or to one who uses the voltage variation as the actuating force. In the end we decided upon the power factor method because that is the primary element involved in the problem. Accordingly, the first prize was awarded to Roland Berti of Omaha, Nebraska, a newcomer to these pages but who, in our opinion, presents an excellent analysis of the problem as well as a good solution. While he discusses other methods, his final selection of a reactive-volt-ampere relay, an instrument which responds to the rkva power in the circuit, seems to be well thought out. He presents a good, clear cut analysis of the problem supplemented by both a wiring diagram and vector diagrams.

The second prize award to Jesse Erisman, was made on the basis of his complete consideration of all factors of the problem and for suggesting several different methods of solution. His plan of incorporating the capacitor control into the circuit of a "key motor" in each department is interesting not only because of its intrinsic merit but also because other contestants suggested this method.

Duplicate third prizes were awarded to J. S. Sawvel of Findlay, Ohio, and to A. R. Markland of Altoona, Pa. Mr. Sawvel presents a most excellent discussion of the problem and his use of a contact-making voltmeter deserves serious consideration. There is no doubt in our minds that this system would work but it is, of course, possible to conceive a variation of voltage due to causes other than power factor change. If, however, the contact-making voltmeter were set to cut out the capacitor only in case of a rise in voltage above normal, there would be very little difficulty in this respect.

The award to Mr. Markland, also, was made because he submitted four different methods of control, in fact he suggested all posssible methods.

FIRST PRIZE AWARD

Roland Berti
Omaha, Neb.

The trouble as given lies in the failure of the Operating Departments' personnel to switch the capacitors on and off as required, and consideration is being given towards placing the responsibility in the hands of the power plant operators. But why rely upon human elements at all? This problem can be very satisfactorily and economically solved by the use of a suitable

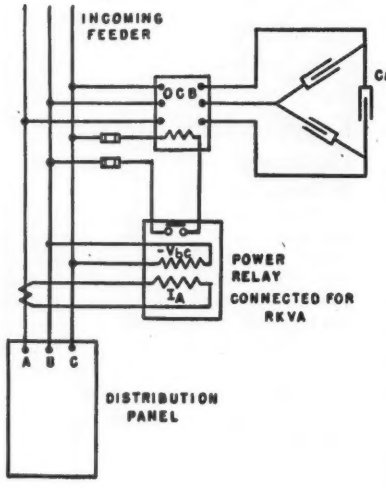


Fig. 1. Wiring diagram of the solution proposed by Roland Berti, using a reactive-volt-ampere relay

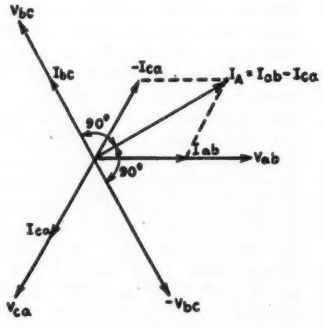


Fig. 2A. Vector diagram of the conditions existing at unity power factor. This shows that the current I_A and the voltage V_{bc} are 90 deg out of phase and thus produce no torque to actuate the relay

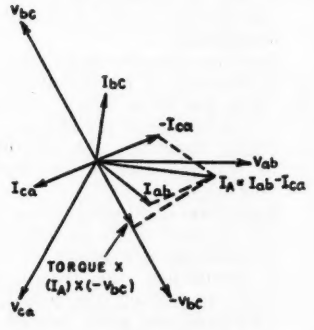


Fig. 2B. This indicates conditions at some lagging power factor and shows that a torque is produced that will actuate the relay whenever the current is great enough or the power factor lagging enough

Problem 37. The Strange Case of the Capacitor Motor

We don't know what has become of Our Hero; he has not been around for some time and we were beginning to get somewhat worried about a problem for this issue. Fortune favored us, however, by placing in our lap, so to speak, a first class mystery—one that would turn Our Hero green with envy. This problem was submitted to us by the manager of a fair sized municipal light and power system. This system is served by a Diesel-electric plant with a total installed capacity of approximately 5000 kw in 6 Diesel units, the largest of which is a 3000 hp machine.

The problem with which we are concerned lies not in this station but in a plant of one of the customers served by the system. It has to do with the peculiar behavior of one of the motors in this plant which happens to be a refrigerating plant. There are two main motors; one is a 40 hp, 300 rpm, 2300 v, 33.3 kva, 60 cycle, 3 phase synchronous motor connected to a 7 by 7 in. ammonia compressor. The other motor is a 25 hp, 2300 v, 1170 rpm 3 phase, 60 cycle, 5.3 amp capacitor motor driving a 6 by 6 in. ammonia compressor through a V-belt drive. The motor has attached to it a polyphase capacitor rated at 15 kva, 660 v, 3 phase, 60 cycles, 13.1 amp, 91.5 microfarads.

There is also installed in the plant an m-g set consisting of a 3 hp, 1730 rpm, induction motor and a 2 kw, 125 v, 16 amp d-c generator.

This equipment is used in an ice manufacturing plant. The synchronous motor runs day in and day out without trouble. The capacitor motor will run all week long, drawing its rated 5.3 amp until Sunday morning about 1:00 to 2:00 a. m. when it will suddenly start drawing over 6 amp causing the overload relay to trip the circuit breaker to this motor. At about 8:00 a. m. this motor can be started again and then it will run at 5.3 amp until 2:00 or 3:00 p. m. when, again, it will suddenly start to pull 6 amp and once more the overload relay will trip the breaker. At the time this case was called to our attention, this had been going on for the previous six week-ends.

The engineers of the municipal system have plotted the loads on the circuit supplying this plant as well as the total load on the station and find that when the total load on the station drops below around 1000 kw this motor will start to draw more amperes. On one occasion (Labor Day) it started this performance and could not be kept operating until the load on the station reached 1200 kw.

There have been occasions when the load on the station dropped below 1200 amp and while the amperage started to creep up on this motor, it did not reach a point where the overload relay operated. The voltage on this line is fairly constant, averaging around 2250 v.

The manager of the system has checked the speed of the compressors with a tachometer and has found them to be constant. The head and suction pressures, he says, have no effect on the motor drawing the current. One Sunday the 40 hp motor was stopped with the head pressure about 140 lb and still this motor drew enough current to trip the overload relay. They have checked every variable that they can think of but the one that seems to have any bearing is the total load on the generating station.

Naturally, this behavior has them guessing. Actually, the shutting down of this motor means a loss of about 6 ton of ice per week to the customer and, of course, a corresponding loss of revenue to the municipal system. The loss of load comes just at a time when it would be welcomed.

The load curves covering all of the six week-ends have been submitted to us but since they all show the same general information we are showing only two of them here.

Naturally this is an involved problem and it can be solved only by detailed study at the plant itself. Nevertheless it is an interesting one and we would like to have the opinion of the readers as to what might be the trouble. Perhaps some of you have encountered a similar case. It will be noted that the manager says that the head and suction pressures on the compressors have no effect on the motor drawing the current. This seems strange indeed because variation of these pressures must affect the load on the motor and consequently also the current drawn by the motor.

In view of the fact that this motor has been running for 12 yr and never "kicked up" until this year makes the problem all the more mysterious.

Write out your opinion of this case in a letter of not more than 1200 words, illustrating it with diagrams if necessary, and send it to us. We will award a $25.00 War Bond for the best letter, and prizes of $10.00 and $5.00 respectively for the second and third best letters. We realize, of course, that from the data presented here it is not possible to make an exhaustive analysis but you may have opinions regarding the source of the trouble that may be of help in solving the problem. The decision of the judges in this contest, will, of course, be final.

Entries for this contest should be mailed not later than October 31, and should be marked, Problem 37. Address all letters to the Contest Editor, Technical Publishing Co., 53 West Jackson Blvd., Chicago 4, Ill.

Voltage and Current Reading on the 6x6 Unit Under Various Suction and Head Pressures

Volts	Amps 6x6	R.P.M. Motor	R.P.M. Comp.	Pressures Suction	Pressures Head
2250	5.3	1170	305	24	165
2225	5.1	1170	305	24	155
2225	5.2	1170	305	24	155
2250	5.4	1170	305	24	160
2250	5.3	1170	305	24	165
2250	5.3	1170	305	24	170
2250	5.3	1170	305	24	165
2275	5.5	1170	305	24	175
2250	5.5	1170	305	24	165
2250	5.3	1170	305	24	170

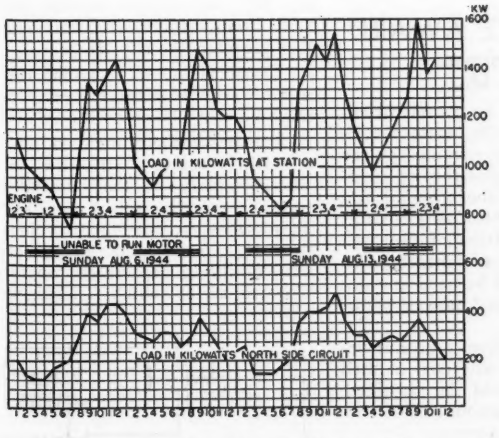


Fig. 1. Record for August 6th and 13th.

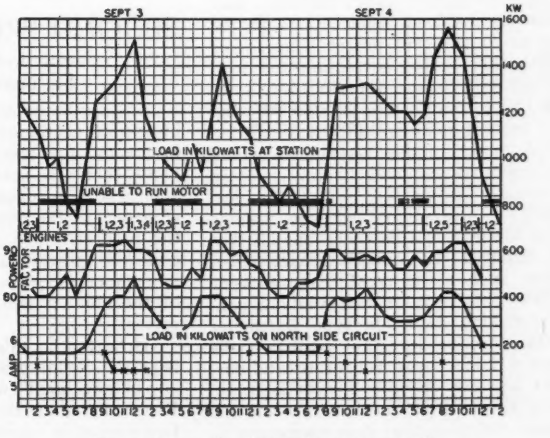
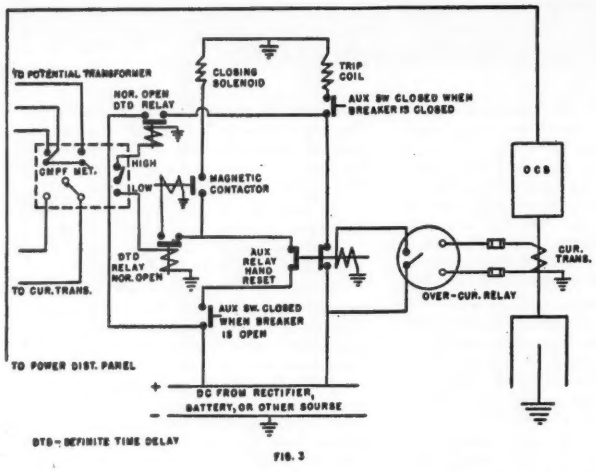


Fig. 2. Record for September 3rd and 4th.



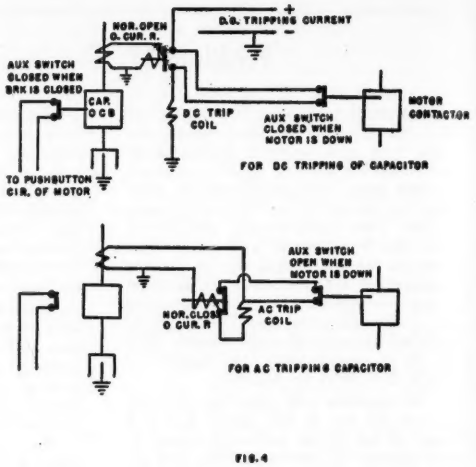

NOR. OPEN O. CUR. R.
D.C. TRIPPING CURRENT
AUX SWITCH CLOSED WHEN BRK IS CLOSED
CAP. OCB
DC TRIP COIL
AUX SWITCH CLOSED WHEN MOTOR IS DOWN
MOTOR CONTACTOR
TO PUSHBUTTON CIR. OF MOTOR
FOR DC TRIPPING OF CAPACITOR
AUX SWITCH OPEN WHEN MOTOR IS DOWN
NOR. CLOSED CUR. R
AC TRIP COIL
FOR AC TRIPPING CAPACITOR
FIG. 4

Fig. 3. Diagram showing the use of a contact-making power factor meter as suggested by Jesse Erisman

Fig. 4. Diagrams showing connections for d-c and a-c tripping of capacitor with "key motor" scheme

relay to automatically switch the capacitors for each feeder off and on as required.

The simplest sort of device would be a current relay which would close the control circuit to the oil switch, and connect the capacitors to the line whenever the building or department load had picked up to full operation. To all practical purposes, using current alone as the criterion for switching the capacitors off and on should be entirely satisfactory. However a current relay alone has no way of sensing the power-factor of the load. Under ordinary conditions of operation a typical feeder may be furnishing, let us say, 250 kw, which would represent normal full load operation for the building it serves. At 480 v and 80 per cent power factor this would mean a line current of about 376 amp and a lagging component of about 187 rkva. Under normal conditions of operation therefore a 180 kva capacitor bank would be used and the current relay set to switch it on at something like 350 amp. However due to a change in production setup or any one of a number of other reasons the load might change. Thus a group of lightly loaded machines may decrease the load requirements to 180 kw at 70 per cent power factor. For full power factor correction the load would still require 180 rkva but since the line current is only around 309 amp the current relay would not operate.

A more suitable instrument would be one that responds to rkva, and so a reactive-volt-ampere relay is the ideal thing to use. Since we can assume that the load is a balanced one all that is required is a single-phase power relay such as a Westinghouse Type CW. This relay is essentially a contact-making induction type wattmeter with a timing lever for adjusting the time it takes for it to operate, and current taps for selecting the watts necessary to set it in motion. To use the power relay so that it is responsive to rkva it is connected as shown in Fig. 1. The current coil is connected in any one phase such as A, and the potential coil across the other two phases B-C. If the relay disc revolves backwards the connections of the potential coil should be reversed. Figure 2a is a vector diagram of the conditions at unity power factor and shows that the current I_A and voltage V_{bc} are 90 deg out of phase and consequently no torque is produced to actuate the relay. Figure 2b indicates the conditions at some lagging power factor and shows that a torque is produced that will actuate the relay whenever the current is great enough or the power factor lagging enough. The torque produced is proportional to the rkva in the feeder circuit.

The rkva in a circuit feeding an industrial load made up largely of machine tools such as would be the case with the feeders in this plant (with the possible exception of those marked "pumps") is subject to continual fluctuation. For this reason the time delay feature of the relay should be set preferably for a several minute delay to obviate the capacitors being unnecessarily switched on and off due to momentary load fluctuations.

SECOND PRIZE AWARD

Jesse L. Erisman
St. Louis, Mo.

The capacitor can be caused to cut in and out automatically, as in Fig. 3, by means of a "contact making" power factor meter, so arranged through suitable relays, to cause the tripping and reclosing of the capacitor oil switch at the predetermined setting of the high and low power factor contacts. An impedance relay could be used in place of the contact equipped power factor meter.

However, in this case, I do not believe the complication and cost of such an arrangement would be justified. Especially, since the amount of correction cannot be varied anyway.

I believe one of the following alternative schemes would be better.

In most manufacturing processes there are at least one or two motors that run continuously while the department is in operation. In other words, we can practically call them "key" motors. For departments that have such a "key" motor, I would equip the capacitor oil switch with an auxiliary switch and connect it in series with the push button circuit of the motor. The auxiliary switch to be open when the capacitor oil switch is open. This would make it necessary for the department operator to close the oil switch of the capacitor before he could put his department into operation.

To insure the disconnection of the capacitor when the department is shut down, I would equip the magnetic switch, or any magnetic contactor that is closed when the motor is in operation, also, with an auxiliary switch. This auxiliary switch to be connected in parallel across the over current relay tripping contacts, if the capacitor oil switch has d-c tripping. If, as is probably the case, the oil switch has a-c tripping, then the auxiliary switch would be connected so as to open the relay contacts that are shunted across the trip coil, thereby causing the current from the current transformer to flow through the trip coil.

For departments in which the "key motor" scheme will not work, I would use an alarm system as shown in Fig. 5.

When the department is placed in operation, current will flow through the secondary of the current transformer, energizing the multi-contact auxiliary relay, causing it to close contacts Nos. 1 and 2, energizing horn circuit, notifying department operator to close capacitor switch. Closing capaci-

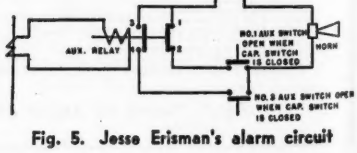


Fig. 5. Jesse Erisman's alarm circuit

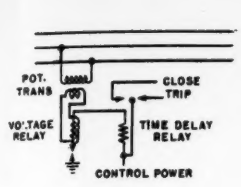


FIG. 6 VOLTAGE CONTROL

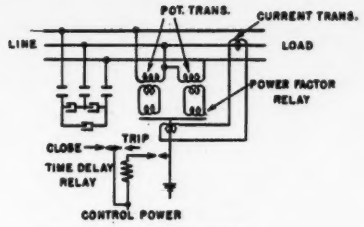


FIG. 7 POWER FACTOR CONTROL

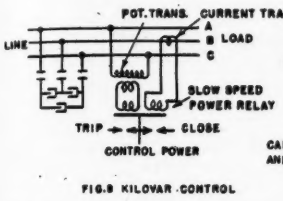


FIG. 8 KILOVAR CONTROL

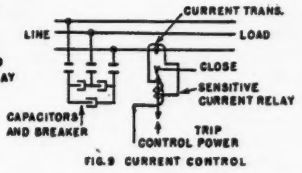


FIG. 9 CURRENT CONTROL

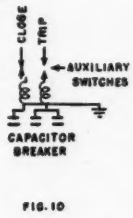


FIG. 10

Figs. 6 to 10. Four different methods of solving the problem suggested by A. R. Markland

tor switch will open auxiliary switch No. 1 silencing horn.

When the department is shut down the auxiliary relays will be de-energized, causing contacts 3 and 4 to close, thereby closing the horn circuit through auxiliary switch No. 2, reminding the operator to open capacitor circuit. Opening of capacitor oil switch will cause auxiliary switch No. 2 to open horn circuit, silencing horn.

Using the latter schemes will return the responsibility of the use of the capacitor to the manufacturing departments, but since the department operator will only have this duty to perform at the start and end of department operation, I do not believe there would be any objections.

THIRD PRIZE AWARD

J. S. Sawvel
Findlay, Ohio

ACCORDING to the conditions given, attendants or operators are available to turn the capacitors on or off in the various departments, but the difficulty lies in individuals forgetting to turn this equipment on or off.

There are two simple solutions to this problem, both of which are dependent upon the fact that the voltage at the point of the capacitor connection increases when the capacitor is connected, and decreases when it is turned off. In addition, whenever correction is needed a lower voltage condition will exist than is desired. Either of the solutions makes use of a "contact making voltmeter". This voltmeter can be adjusted so that it makes contact when a predetermined low voltage is reached and opens contacts when a higher predetermined voltage is reached. The predetermined voltage limits would be obtained from actual tests as to the voltage available at any one capacitor location when there is sufficient capacitors in operation to provide the necessary correction and also the lower voltage available when the capacitor equipment should be connected. These two plans utilizing this principle are as follows:

PLAN A This would be the lowest cost plan and would involve the use of the contact making voltmeter which, when the voltage is too low, would operate, in a prominently displayed location at the point where the capacitor oil switch is located, a red lamp. Underneath this red lamp would be printed in large letters—Capacitor Switch Should Be Closed. When this lamp is lighted, it would give visual warning to the responsible attendant that he should see that the capacitor switch is closed. The electrical features would be that when the contact is closed, an auxiliary relay would be operated, which in turn would energize the lamp, the relay being the type whose contacts are *normally open when no voltage is impressed upon same.* This auxiliary relay is only necessary to protect the comparatively delicate contacts of the contact making voltmeter.

When correction is not needed, as is evidenced by the fact that the voltage would be "normal" or at whatever level is desired, the contact making voltmeter contacts would be open and operate an auxiliary relay whose contacts are *normally open when voltage is impressed upon same, and closed when no voltage exists* (the condition that would exist when the contact making voltmeter contacts are open due to high enough voltage present). The operation of this relay would light a white lamp under which there would be prominently lettered a sign stating: Capacitor Switch Should Be Open. There are small relays available into which both of the above features are incorporated; i.e., one set of contacts "are closed on voltage" and the other set of contacts "are closed on no voltage". The cost of such installation should not be more than about $30 or $40 per capacitor location.

PLAN B Plan B utilizes the same equipment as Plan A except that if complete automatic operation is desired, the oil switches controlling the capacitors would be equipped with a solenoid so that same can be operated electrically. The contact making voltmeter, in connection with the auxiliary relays mentioned in Plan A, would open or close the oil switch according to the desired voltage conditions.

Summing up the above scheme, which is about the simplest that can be devised, is that the voltage conditions would be measured at the time sufficient corrective equipment is connected to the system, and any voltage lower than this by some predetermined value indicates that the capacitor equipment should be connected to the line, and any higher voltage above certain desired limits indicates that the capacitor equipment should be disconnected. For example, as compared to a 120 v base, when the voltage exceeded 124 v the *white* light would be turned on indicating that the capacitor bank should be disconnected. When the voltage was less than 120 v the *red* light would be lighted (or if desired a bell alarm could also be sounded) indicating that the bank should be connected.

Assuming the generator is operating on a constant voltage basis with a voltage regulator controlling the voltage, the *lower voltages* at the load or the end of the distribution system will exist when the loads on the system are at maximum values. *When voltage conditions at the load are at a maximum*

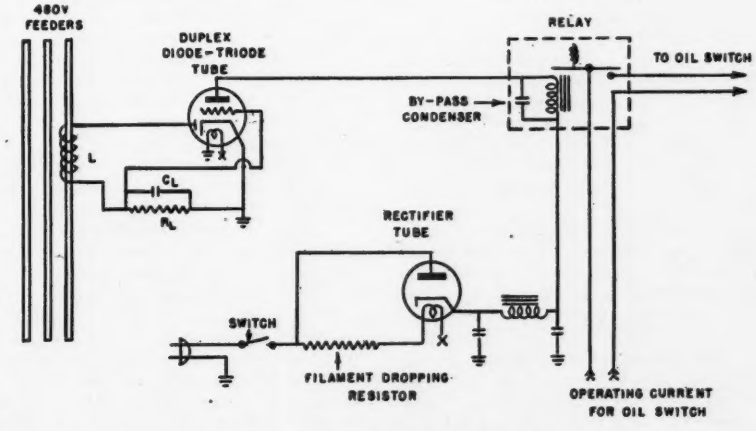


Fig. 11. Leon Carter's electron tube solution

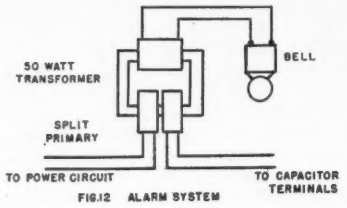


FIG.12 ALARM SYSTEM

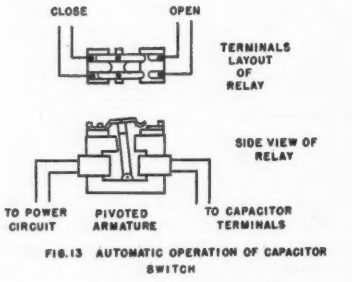


FIG.13 AUTOMATIC OPERATION OF CAPACITOR SWITCH

Figs. 12 and 13. Two arrangements submitted by Thos. W. Benson

value with the same voltage being maintained at the generator terminals indicates that a minimum of correction is required and the load is considerably less than the maximum.

The important thing is to maintain a high power factor at the time of maximum demand and it is not ordinarily objectionable if the power factor is somewhat low when the load is light.

DUPLICATE THIRD PRIZE AWARD

A. R. Markland
Altoona, Pa.

SINCE the use of carrier current or pilot wire control for switching the capacitors is ruled out because of the expense and control by a slight variation in the frequency is out on account of the tie with the utility service, the only alternative is to perform the switching automatically, by the load. This can be effected by:

1. Voltage at the ends of the feeders
2. Power factor of the load
3. Reactive kilovolt amperes or to use the modern term (kilovars)
4. Current of the load

If the primary object of the capacitors is to assist voltage regulation, the first method, control by voltage, should be used. This would require a potential transformer, voltage relay or contact making voltmeter, and a time delay relay or a slow speed voltage relay for the control of each capacitor bank. Figure 6.

The second method, power factor, has no particular advantage and would require two current transformers, one potential transformer, a relay sensitive to power factor and a time delay relay. Figure 7.

The third method, kilovars, would be desirable if changes in the load might occur which would cause a large change in the kilovars without a corresponding change in the current. This might occur if a large part of the load were driven by synchronous motors but would scarcely be the case in this problem, as capacitors are usually installed with induction motor or spot welder loads. This method requires one current transformer connected in phase B, one potential transformer connected to phases A and C and a slow speed relay. Figure 8.

The fourth method (load current) appears to be the cheapest and as effective as any other for this particular case, especially as instantaneous sensitive plunger type current-operated relay is available with a pick-up range of two to six amp, a continuous capacity of six amp and a drop-out range of 0.6 to one amp. By feeding this type of relay from a current transformer of a ratio to apply 5 amp to the relays at full load, it could be set to switch the capacitors on at any point from forty per cent to one hundred per cent load and switch them off when the load drops from twenty per cent to twelve per cent of full value. This relay could probably be used without a time delay as shown in Fig. 9.

Any of these arrangements would require the installation of opening and closing coils and auxiliary switches on the capacitor circuit breakers for opening the coil circuits after the breaker has operated. Figure 10.

Honorable Mention

Among the solutions that deserve special mention because of a different method of approach, first, is the solution submitted by Leon Carter of Charleston, S. C. Mr. Carter was the only contestant who used electronic tubes in solving the problem. Whether or not the use of tubes can be justified in a case of this kind would have to be proved but Mr. Carter's system could be made to work. The system operates by virtue of changes in current and the end result is the same as if conventional current transformers were used but the use of tubes eliminates the need for current transformers. Mr. Carter writes as follows:

"I believe the problem can be solved with automatic control, by a vacuum tube circuit to operate the capacitor in each building according to the amount of current flowing through the 480 v feeders. The circuit is shown in Fig. 11. I believe this method of control would be cheaper to install and just as dependable as remote control. Here is how it works:

"Coil L is wound around one of the feeders coming into the building. Current flowing through the feeder produces a magnetic field which induces an alternating voltage in Coil L varying according to the amount of current flowing through the feeder.

"The diode section of the duplex tube rectifies this induced voltage and the resultant direct voltage forces a direct current through R_L, the diode load resistor. Condenser C_L helps make the current flow constant through R_L by discharging through it on the half

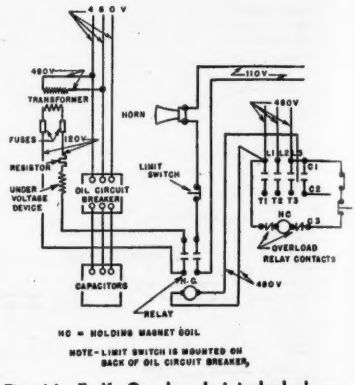


Fig. 14. E. K. Goodman's interlocked warning system

cycle when the current is not flowing from Coil L. The voltage drop across R_L is applied to the triode section grid, thus controlling plate current in the triode section and the operation of the relay which control the capacitor oil switch.

"When a certain predetermined value of current flows through the 480 v feeders, Coil L has enough induced voltage and resulting current to produce across R_L a voltage drop sufficient to make the triode grid negative enough to cut off the plate current flow through the triode section. This causes the relay coil to be de-energized and the spring pulls the armature of the relay to close the circuit to the capacitor oil switch.

"When the current flow in the feeders drops below this value the reverse of the above action takes place and the capacitor is cut out of service. The rectifier tube and its circuits furnish d-c operating power."

Thomas W. Benson submitted a solution that was quite different from any of the others but one that is, nevertheless, interesting and ingenious. He suggests either of two arrangements, one a warning system indicating to the operators when the capacitors should be cut in or out, and the other, an automatic system. The same underlying principle is used in both arrangements. Mr. Benson's scheme is shown in Figs. 12 and 13.

"The system makes use of a small transformer having two primary windings. These are wound for 480 v each while the secondary may be any nominal voltage to operate a large bell.

"One of the primary windings is connected across the capacitor terminals and the other winding across the terminals of one of the motors in the department. It is necessary that the connections be made across the same phase to assure proper operation. The connections are also made so the fields of the two primary windings are in opposition when current is flowing through them under which condition no current will be induced in the secondary of the transformer.

"The operation is as follows: When the department starts up the motor

Joe it is unnecessary to have to replace some of your boiler tubes every few weeks"*

says Jerry Liedholz
Nalco Representative,
Ann Arbor, Michigan

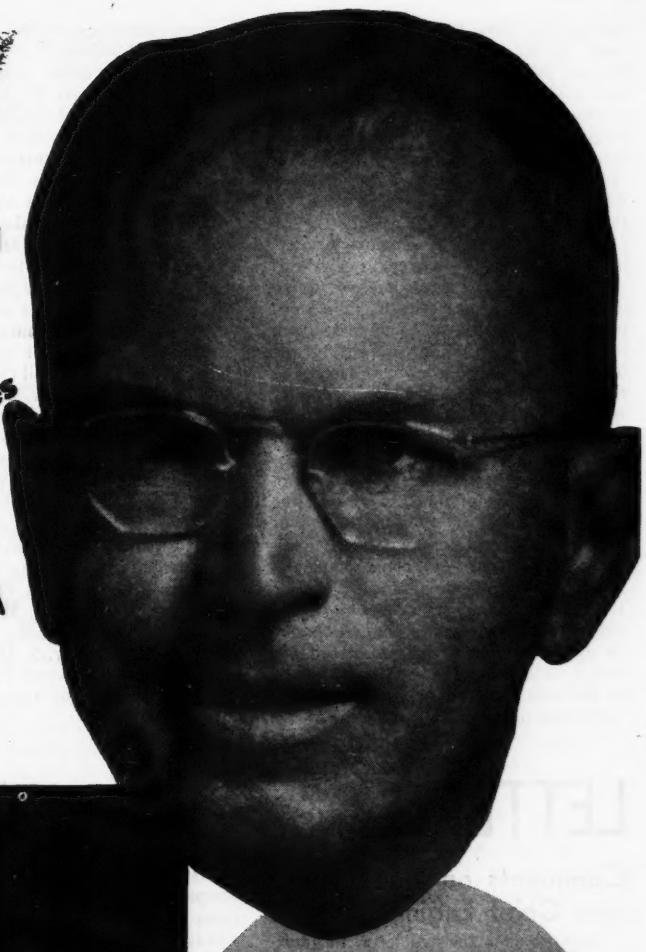


Photo in Nalco Laboratories

* Joe, an Operating Engineer at a Utility Station says—*"Bad water conditions are our worst headache . . . I imagine we replace ALL boiler tubes over a period of seven years time . . ."*

Source: Survey conducted by a well-known power publication.

• We realize, Joe, that in a "hot" standby station, pitting action is accelerated in the idle boilers—but every few weeks is much too often to replace even part of your boiler tubes. Get rid of pitting, excessive oxygen and scale with Nalco water treatment and you have taken a big step toward curing those "boiler tube" headaches.

Put us on the spot, Joe—call a Nalco representative today and lay your pitting trouble at his feet. He will show you what we mean when we say *"Nalco—the complete water treating service."*

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current will flow to the left hand primary winding which causes current to flow in the secondary winding and the bell will ring to remind the operator to close the capacitor switch and it will keep ringing till this is done. Upon the capacitor switch being closed, current flows in the right hand primary which, opposing the field created by the left hand winding, results in no current flowing in the secondary winding and the bell is silenced.

"When the department shuts down the operation reverses itself. The stopping of the motor takes current from the left hand winding permitting the field from the winding connected to the capacitor to energize the secondary winding again and the bell starts ringing and keeps ringing till the capacitor switch is opened.

"The second method employs automatic operation of the capacitor switch if the expense of installing motor or magnetically operated switches is justified. In this case we could employ a relay built on the lines shown in Fig. 13. A pivoted armature arranged between two poles carries contact fingers to operate the control circuits of the motor actuated switch. The windings of the relay are wound for 480 v and connected in the same manner as the primary windings of the transformer previously described."

Among the other contestants deserving mention are E. K. Goodman, electrical foreman at Engleheart Brothers, Inc., Evansville, Ind. Mr. Goodman discusses the question of using a fully automatic system but feels that in this case a warning system would suffice. His scheme makes use of the "key motor" principle and he incorporates a pair of contacts on the starting switch of this "key motor" which through the agency of a relay operates a horn or other warning device and also closes the circuit to the under voltage device on the oil circuit breaker serving the capacitors. The horn will continue to sound until the capacitor circuit breaker and its associated undervoltage release mechanism are thrown in.

Homer H. Crider, of Yosemite National Park, Harold D. Remington of Saginaw, Mich., Gerald W. Benedict of Montpelier, Vt., Ronald J. Martin of Elizabethton, Tenn., William E. Glennon of Cincinnati, O., Victor N. Friedman of St. Louis, Mo., Sam Williams of Wingdale, N. Y., LaVern Green of Rapid City, S. D., and Daniel S. Olafson of Elmwood Park, Ill., also deserve mention for the excellence of their solutions.

LETTERS AND COMMENTS

Comments on Incompetent Chief Engineers

HAVING READ the article on Incompetent Chief Engineers on page 99 of the July issue by M. J. S., I thought it was well put and can understand from the way the article was written that M. J. S. has been around. As for his opinion that Chief Engineers are incompetent, I don't believe he means all the Chief Engineers.

Regarding M. J. S.'s question, "where can you find a Chief Engineer that will openly discuss all phases of the running of the plant *with all of his men* slighting no one" there may be a few of these around but I haven't encountered one.

M. J. S. wonders why there are so many chief and operating engineers that are reluctant to tell another man something that might broaden his scope in the engineering field. I have noticed this many times and it would be a good time for someone to try and answer this and I am sure that once this discussion is started the fireworks will begin and it will be good for both the chiefs and the operating men alike.

Another good point brought out by M. J. S. is that management is often blamed for conditions that are really the result of the chief engineer's actions. Take plants, for example, where the management understands that the cost of living is higher, and would willingly raise salaries if the chief would O. K. such a plan. Does he do so? No, he wants to look efficient in the eyes of the company or he lets someone come down from the office with a lot of two-bit words and talk him out of it.

In the power plant engineering business, there is always something new developing and this means that the good engineer and operator must keep abreast of those developments so as to be up-to-date on operating equipment.

I like what M. J. S. says about his being an engineer and about reading his textbooks and subscribing to a good trade journal. I also like him for asking the opinion of his men.

In one large plant working on vital war material, a chief engineer had a fireman fired because this poor dumb guy was the only one who knew the underlying cause of a great deal of damage to a boiler. The boiler inspector, superintendent, chief engineer, and the maintenance boss had looked the boiler over for two days and couldn't make out the cause of it. This "dumb fireman" as he was called later, said to the chief, "I think I know the trouble," and he called the shot right on the nose. As soon as the trouble was found the fireman was discharged. The boiler manufacturer had to make good the repair and this chief engineer has not only held his job but has had an increase in salary as well. This same chief stopped the men from getting paid time-and-a-half for working on Saturdays and Sundays because the men only worked five days a week and this was before the war when a couple of extra dollars came in handy. As the watches or shifts rotated each man got as much as the other fellow. When I read the article, I was reminded of some of the incompetent chief engineers I have seen, who seem to think they know it all and refuse to listen to anyone else. This isn't meant for all the chief engineers, as I believe there are many good ones still about.

Philadelphia, Pa. W. T. M.

No Substitute For Practical Experience

IN RESPONSE to the article in the September issue by Vancil F. Hill entitled, "The Boiler Operator—The Forgotten Man," the first part of his statement is the general opinion of most people. He discusses the question of college graduates as engineers in power plants. As supervisory personnel that could work, but there are hundreds of firemen who know more about the actual operation than any college man could know. Unless a man has the practical experience he is in very many instances utterly useless, regardless of education.

I firmly believe if a fireman has education enough to figure costs of operation and maintenance and to operate the boilers and equipment safely and has had at least 5 yr experience he is entitled to have opportunity to advance. He should study good textbooks and become informed along technical lines. The college man might out-figure the practical man, but in 99 cases out of 100 if something went wrong in the operation of boiler room equipment, the college man would have to have the insignificant fireman to hold him up. I have seen such things happen quite often. How many men ever become expert firemen by going to college?

I do not wish to criticize college education or college men, but unless a man knows how the job is done and has performed the duties with his hands, he is only a figurehead and the man who gets no credit if all goes well, and gets all the blame if it doesn't, is the man who makes the plant go. If all engineers had to pass an examination like the one we get in St. Louis, there would be no question as to his ability, whether college man or grease-ball. Personally, I think we should have more co-operation from licensed engineers. They should acquaint firemen with the workings of a plant and how to discharge his duties in an efficient manner, and if he wanted to go to the trouble to become an engineer, help him to get textbooks and study the engineering job from A to Z. It isn't the educated man who is the dangerous man in a power plant, it is the uninformed or shall I say the man who hasn't operated a boiler or boiler room equipment. I will take the practical man, the old timer, who has knowledge enough to operate safely and efficiently with or without a college education.

St. Louis, Mo. WILLIAM R. GREEN

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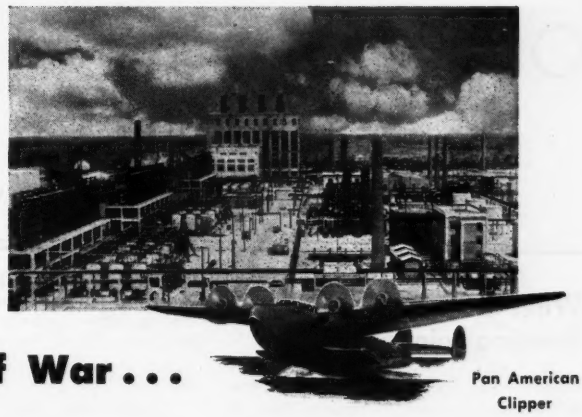

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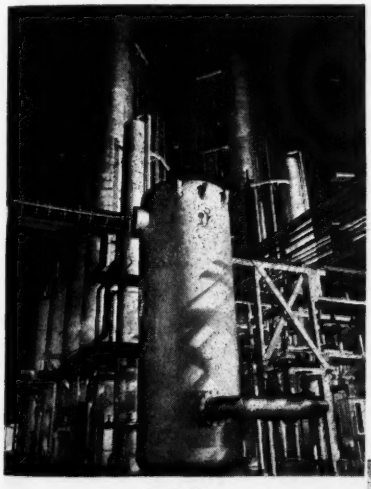

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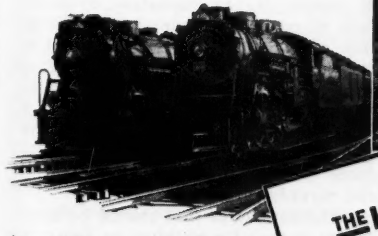

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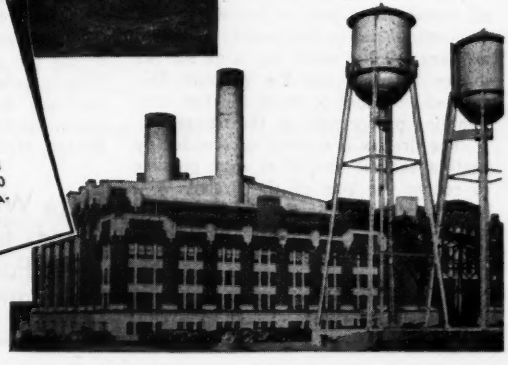

High Pressure Steam and Power

Questions And Answers

Question No. 275

What Is P-T Relation at Freezing Point of Water?

IF A VOLUME of pure water containing no gas could be confined in a comparatively strong sealed container, such as a closed steel cylinder with a wall thickness of say three inches, so that all the space was filled with liquid, and the temperature of the cylinder was then reduced to a temperature below freezing, would the water still remain in a liquid state, no matter how far the temperature was lowered, as long as the container was strong enough to prevent the usual expansion in volume that occurs when water changes from a liquid to a solid? In other words, what is the temperature-pressure relationship that applies to the freezing point of water?

Baltimore, Md. W. E. P.

Question No. 276

How Improve This Domestic Furnace ?

SOME YEARS AGO, an elderly friend, since retired, bought the unoccupied mansion of a small town magnate who had gone on to greater magnificence. The heating plant in this mansion is an antique—a vertical, low-pressure boiler, with a round fire box big enough to hold a quarter of a ton of anthracite. I'd say, off-hand, that it is three feet in diameter by a couple of feet deep. Heretofore, wood has been burned by the present owner and I was able to help him save a lot of fuel by covering the major portion of the coal grates with fire-brick.

It is no longer possible to buy wood and this coming winter he will have to burn coal, several tons of which have already been obtained. It is very likely that there will be difficulty in getting an adequate amount for the whole season, to say nothing of the expense.

All the rooms not in use will be shut off, leaving only four or five which will absolutely *have* to be heated. So here we have a boiler much too large for the service required and the problem is—what can be done to make the fuel consumption proportional to the demand?

The firebox is entirely surrounded by heating surface and, if it were possible to reduce the size of the firebox with refractories, there would be, I assume, reduced efficiency. Would it be possible to invent some form of water wall, reducing the size of the furnace?

If so, how would you hook it up and of what material would you construct it? The grates are of the rotating type with three working surfaces, three bars to a section and two sections. Would it be possible to partially cover the outer circumference of the grates and to construct, out of pipe, an inner cage for the fuel?

If this seems like a large order, you will be interested to know that any practical ideas will be a great benefit to a very old man whose working days are over, whose income is very limited, and who has been, and still *is*, one of the best.

Peterborough, N. H. A. H. P.

Question No. 277

Why High Potential to Ground But Little Current?

IN OUR POWER PLANT, our house service auxiliaries are supplied with power through a 4800/440-v 60-cycle, 3-phase, 3-wire, delta-connected transformer bank. Upon making a voltage test on the secondary or 440-v side of this transformer from each phase to ground, we get the following readings:

Phase A Voltage to ground 185 v
Phase B Voltage to ground 190 v
Phase C Voltage to ground 185 v

However, when inserting an ammeter with a 0 to 5-amp scale in series with each phase to ground, we do not get a deflection great enough to get a reading. Therefore it appears we are getting quite a high potential from each phase to ground but practically no current is flowing.

I would appreciate your explanation of this condition.

Wyandotte, Mich. H. E. A.

Question No. 278

He Wants to Know About Dehumidification of Air

I WOULD APPRECIATE any information from readers on air dehumidification.

Most of the literature I can find about air conditioning deals with cleaning air and adding moisture to it. However, our company is a wall paper manufacturing concern and our problem is drying the paper, especially in summer. This is quite a problem, when temperature and humidity of the outside air are in the 80's and 90's, as they are here.

Boston, Mass. A. B.

Question No. 279

Data Wanted on Indicator Cards from Straight-Line Pumps

CAN YOU GIVE me some information about the steam engine indicator and its diagram applying especially to straight-line pumps, compound and triple-expansion types? These pumps I have to take cards from are good-sized units—18 by 28 by 48 by 9½ by 36 in. I have two books on the steam engine indicator but they do not show any cards or give any information on cards from pumps of this type and size.

Coalinga, Calif. F. W. S.

Answer No. 263

Why Forbid Flax Packing on Water End of Pump?

Use Flax Only with Cold Water

I CAN READILY understand why S. J. A. wants to know why this packing can't be used. It seems to me that S. J. A. is one of the old timers around power plants; from the respect that he gives this flax packing, he must have had plenty of experience with it, and I'm just the kind of a guy to say "Hooray!" for a fellow that will holler and squawk for the things he believes in.

Having worked in power plants ashore, in the Navy, the Merchant Marine and on dredges, from what I've noticed recently is that only on cold water is the flax packing used and it holds up very well. The rods of reciprocating steam pumps (steam end of pump) are packed with steam packing, the plunger of the feedwater pump uses duck packing; on the water end of these rods is a packing composed of steam packing with rubber inserted center. But to check again, consult a reliable packing manufacturer and he will only be too glad to give information and lend you assistance.

As for the breaking of the glands and packing nut breakage, I can understand the gland breakage, but doesn't S. J. A. mean the nuts are stripped and not broken as he states? The breaking of glands on the steam and water ends, is a sign of someone tightening glands that doesn't know how to, and if this person is checked back carefully it will be found that he is the cause of the trouble and not the material in the glands.

Yes, I do agree with S. J. A. that flax packing is good, but it should be used only on valves or pumps that handle cold water.

When packing the pumps or rods of pumps, it's as important to know how to pack and maintain the condition of the rods and recesses as it is to pick the proper packing at all times. If the recess isn't cleaned of all packing then when the new packing is inserted, it will create a hump, the gland will not be true and trying to force it will break the gland or strip the threads on the nuts.

Another factor that should be mentioned is that the packing, as its name implies is made with a flax ingredient and, as linseed oil is obtained from this flax seed, the hot water pumped by the feed pump will absorb this oil and carry it in to the boilers. And this is one of the things that must be kept out of boilers at all times, to prevent scaling.

Philadelphia, Pa. WILLIAM T. MULLEN

JOHN CRANE

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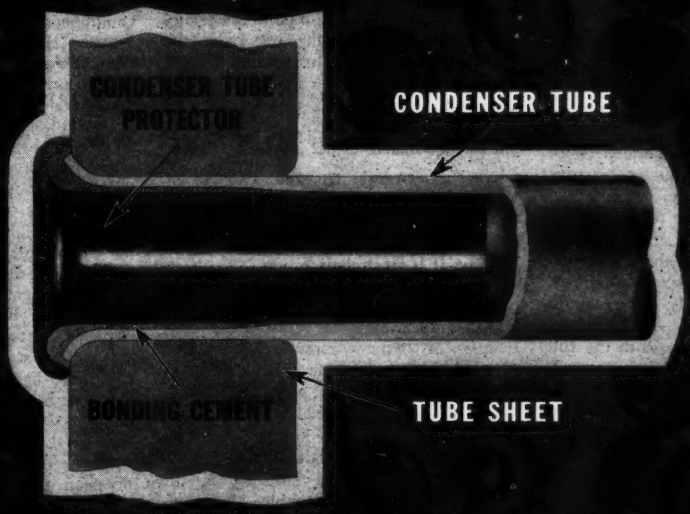

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Answer No. 264

What Causes Stoker to Smoke and Gas From Hopper

How One Case Was Cured

WITH THE HOPE that this may be of assistance to E. K., I am submitting the following experience with a single-retort, hydraulic-ram stoker on a 160-psi, 150-hp boiler. The fuel was run-of-mine coal (slack) from Pennsylvania mines.

Smoke was occasionally noticed coming from the hopper in small amounts. It gradually grew worse, over a period of time, and it was noticed that it was particularly bad in the morning, after the watchman had brought up steam pressure preparatory to starting at 7 A.M. Investigation disclosed that the fire in the retort had gradually burned back into the hopper during the night. This had formed a hard carbon and ash that threw a heavy load on the stoker, besides burning and checking the piston plunger.

To overcome this, instructions were given to the night watchman on his tour through the boiler room to throw in the switch and allow the stoker to operate for 5 or 6 strokes. The effect of this was to carry the fuel forward in the retort and prevent it burning back into the hopper.

It was also occasionally necessary to spin open the bypass valve on the stoker so that the plunger piston was in the full forward position, and stopped there.

A small crow bar was then thrust down through the coal, and any carbon that had formed was broken up, and carried forward with the fuel into retort. This was repeated as necessary, until free operation was obtained, and smoke no longer appeared when forced draft went into operation.

Photo by Jesse F. Clack to show how tubing was installed from single-shot lubricator to stoker drive cylinder

The next difficulty that appeared was the plunger piston sticking, and causing the stoker to operate at excessive oil pressure.

This was overcome by setting the plunger in the full forward position so that it left the larger portion of the cylinder clear. Next, using an electric drill, six holes were drilled at approximately mid-length of cylinder, equally spaced around it. These were tapped for a ⅛-in. fitting of a "single-shot" lubricating device manufactured by Bowen Products Co. of Auburn, N. Y.

This device is inexpensive, and by means of a small lever about 1 ft long 500 lb pressure could be exerted to force a shot of oil simultaneously at six points around the piston to relieve the drag when it became necessary. A low grade of black oil was used.

In a sense, it was not lubrication that freed the piston, but the fact that the oil softened the carbon forming on the piston, and this was then wiped free by the backward and forward motion of the stoker. This method was in successful operation for six years, until the writer left to engage in war work on the Pacific Coast.

When the stoker is not under automatic control, or when it is to be left "stand-by" for any length of time, the plunger piston should be "coaxed" into the full forward position as it thus blocks the fire from burning back into the hopper. The small copper tubing that carries the lubricating shot of oil can be seen in the photo. The tubing carrying the oil from the plunger pump on the lubricating system should, if possible, be run so it will be subject to enough heat to keep the oil freely flowing in winter.

Manhattan Beach, Calif. JESSE F. CLACK

Answer No. 265

What Is Eating Up the Fusible Plugs?

He Says It Is Electrolysis

THE EATING AWAY of the fusible plugs in M.G.'s boilers is no doubt, as the insurance inspector states, the electrolysis or battery action. This action is very common where two different metals are in contact with each other and also have a contact with a water contaminated with or holding minerals in solution. Common salt or any sodium compound besides the chloride is the usual source of such trouble. The sulphates or phosphates also provide means for causing electrolytic action.

There is so little pertinent information given by M.G. in connection with his question that it is impossible to give a positive answer to his question as to what causes the electrolytic action. If he has a high-pressure boiler and maintains a sulphate-to-carbonate ratio, the action may be caused by the sulphate concentration. If all the feedwater is zeolite-softened, there may be enough alkalinity to allow electrolysis to take place. If phosphates are used to treat the water the residual soluble compounds may cause the action.

The use of tannates or other organic compounds as a water treatment will not in themselves produce the action. Electrolysis is accelerated by temperature and pressure; thus the action under identical boiler water analysis is more rapid on a boiler at 750 psi pressure than at any lower pressure, due principally to the difference in temperature.

To cause this electrolytic action, there must be what is called a closed circuit for the flow of an electrical current. The fusible plug in the boiler is eaten away for the same reason the zinc plate was eaten away in M.G.'s experience in marine work. There the salt water is one of the best liquid conductors so that the action is much more rapid than in an ordinary boiler.

In cases where the fusible plugs are eaten away more rapidly than the boilers need inspection, the use of zinc strips over the plugs as protection may be an advantage.

Lakewood, Ohio JOHN P. SIMONS

Answer No. 267

Will Increased Clearance Cure Valve Slap?

HIS 12-by-14-in. twin Brownell variable-speed steam engine has always had a bad valve slap on the head end, said R. H. in the August issue. Cards show very high compression. Piston clearance is 3/8 in. At low speeds he can stop the valve slap by opening the ½-in. cylinder drains. Therefore, he wonders if a plate could be set under the cylinder head to increase the clearance. If so, how thick should the plate be? How would this affect engine efficiency?

Exhaust Valve Lap Should Be Reduced

THE BROWNELL ENGINE has what is commonly known as a "balanced valve." The pressure plate and valve are so designed as to provide an excess area on the valve as compared with the area of the pressure plate, so that this excess area on the valve, when acted upon by the pressure in the steam chest, is intended to be sufficient to hold the valve on the valve seat. R. H. states that indicator cards show a very high compression. From this statement, together with the fact that he is complaining of a valve slap, it is natural to assume that the compression pressure is high enough to lift the slide valve off its seat.

Such compression is too high. Compression pressures should never exceed the initial pressure.

R. H. states that this twin engine unit is variable speed — 75 to 400 rpm. He does not state how the engine is controlled but, being variable speed, one would assume that the control is entirely by hand. However, it might have some type of special governing mechanism which provides for this wide range of speed control so that the engine may at times be operating at the low speed and for some other purpose may be operating at any speed within the range specified. If the unit is hand-controlled it is quite possible to give such a unit sufficient steam to operate at any speed within the range, but (particularly if operating at the high limit) the throttle may suddenly be closed and it would only be natural that the valve would slap because closing the throttle would take the pressure off the slide valve.

The question is presented by R. H. in such a manner as to leave one to the viewpoint that the engine operates at a regular speed, whatever that speed setting might happen to be. If, under that condition, the compression is very high, the valve slaps, and if this condition occurs on one end only, the correct procedure would be to reduce the exhaust valve lap for the head end of the cylinder.

It is to be assumed that the steam distribution has been properly equalized and that the indicator card shows correct steam distribution. However, it must be that the compression is higher on the

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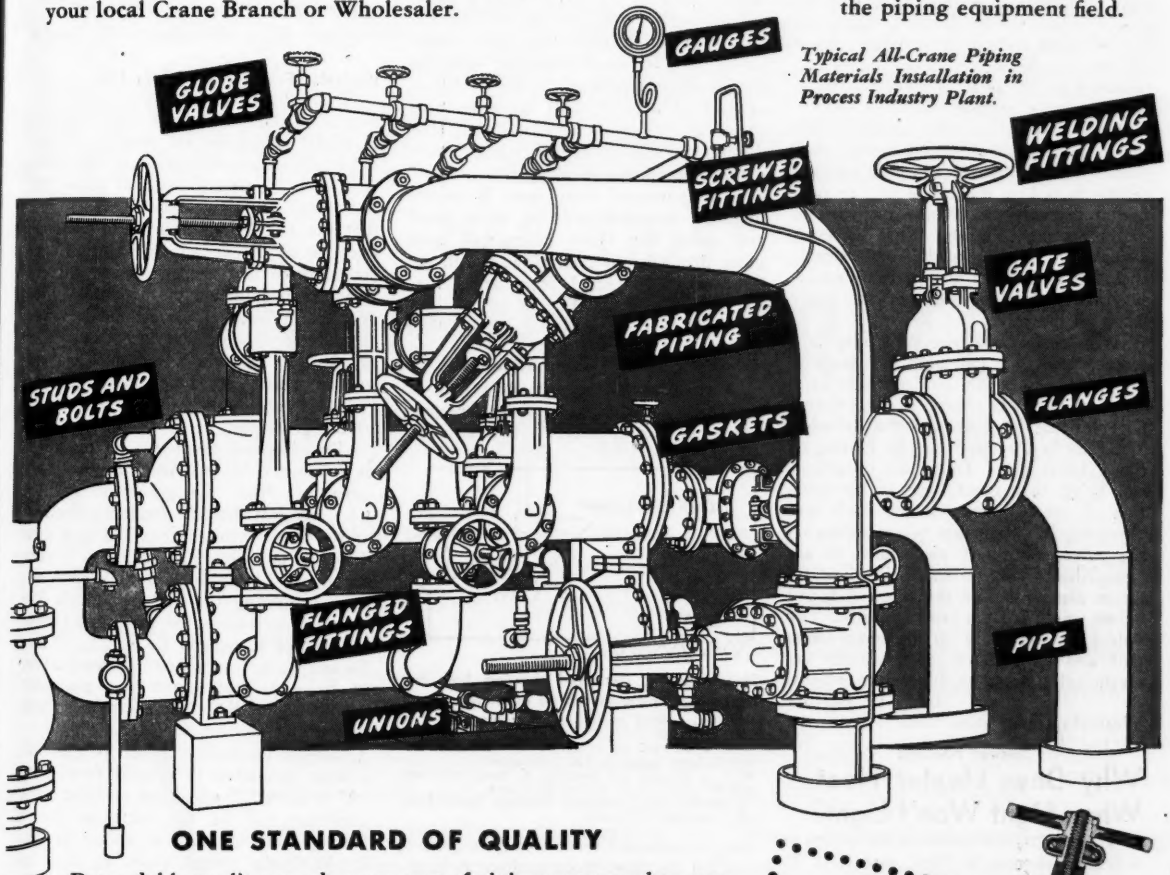

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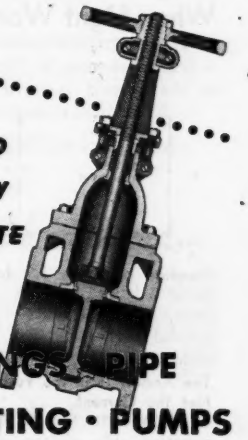

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head end than on the crank end, since it has no slap on the crank end.

I am inclined to think that R. H. has not carefully equalized the steam distribution and that he has less compression on the crank end than on the head end. I suggest the correct procedure would be, first of all, to carefully equalize steam distribution, but if there is irregularity in the exactness of valve design, it will be impossible to obtain exactly equal steam distribution as shown by the diagram. He should particularly watch the point of admission and the point of release just before the end of the stroke. After proper equalization, or if he finds it impossible to get exactly equal distribution, he should then adjust the valve for correct distribution of the crank end and if, out of that condition he has still too high compression on the head end, he should reduce the inside lap of the valve for the head end of the cylinder, being careful in reducing this inside lap not to reduce it so far as to sacrifice too much on the exhaust release.

I have, from the first, assumed that R. H. has obtained the exact correct position of the eccentric; however, in his procedure to reduce the inside lap, he may find it necessary to change the position of the eccentric slightly. This, however, I feel sure his knowledge and experience will indicate to him as being necessary after removing some of the inside lap from the valve.

It is evident that the valve slap is a direct result of too high compression pressures. That can only develop as a result of too early closing of the exhaust port for the head end of the cylinder. The remedy for this is a later closing of the exhaust port. Only two conditions can bring that about: one is the position of the eccentric on the shaft and the other is the amount of inside lap on the valve. Both of these must be accomplished without sacrificing correct steam distribution on the crank end, and on all points for the head end also. The defect appears to be on the compression only and the removal of the inside lap on the valve would be the correct remedy.

HARRY W. BENTON

West Hartford, Conn.

Answer No. 268

Why Does Heater Heat When Light Won't Light?

IN THE CIRCUIT shown in the sketch is a heating element R. Now, said J. D. T. in the August issue, a test lamp connected from area A to ground will light, but connected from area B to ground will *not* light. Yet the entire element R heats up. Why?

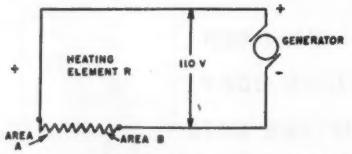


Diagram of J. D. T.'s heater connections

The Answer Is in the Voltage Drops, Not the Current

FROM THE sketch it seems that the negative side of the generator is connected to ground. Therefore, the area B of the heating element is near ground potential. The connection is such that the current flows through the whole element; that is, the current through that part of the element indicated as area B is the same as that through that part indicated as area A. Therefore, the heating would be the same at either end.

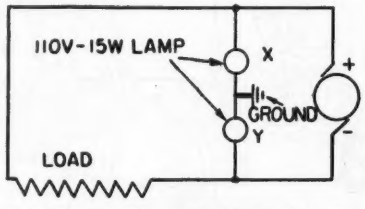
If now we consider the connection of a test lamp from area A to ground, it will be noticed that we are measuring almost the entire generator voltage; that is, the resistance drop from the positive terminal of the generator to the area A will be small since this is all regular wire, probably a copper conductor. On the other hand, from area A to area B, the current is passing through resistance wires and the drop will be considerable. As a matter of fact, the drop from the terminal at the end of area A to the terminal at end of area B will be almost as great as the generator voltage, (the difference will be simply the voltage drop through the conductor).

The potential from area B to the negative terminal will be very small and since the 110-v lamp will need more than 65 v to even glow, it will not light when connected from area B to the negative terminal.

Madison, Wis. J. E. WISE

Potential Drop to Ground Explains It

THE NEGATIVE side of generator or resistor is probably grounded either purposely or accidentally. When the test lamp is connected from area A to ground, you get the drop from positive to negative. When the test lamp is connected from area B to ground, both sides of the lamp are at ground potential, so the lamp does not burn. The heating element is across the full voltage and, of course, heats up.



Sketch by H. Denmead showing how two lamps can be connected on grounded circuit
With no ground on system both lamps burn at half brilliance.
With a ground on negative, Y lamp goes out and X lamp burns at full brilliance.
With a ground on positive, X lamp goes out and Y lamp burns at full brilliance.
On partial high resistance grounds, lamps burn with unequal brilliance.

If J.D.T. will connect a set of lamps as shown in the diagram, lamp Y will not burn and lamp X will be at full brilliance with a ground on the negative side. The reverse is true with a ground on the positive side.

Pittsburgh, Pa. H. DENMEAD

Resistances Explain It

IN THE AREA "B" the resistance of the wire between that point and the generator is less than the resistance through the lamp and through the ground to the generator, therefore, the lamp will not light because no current will flow through it.

In area "A" there is enough resistance between there and the generator so that current will flow through the lamp and ground back to the generator, causing the lamp to light.

Similar results can be noted by hooking a lamp in parallel with a fuse; as long as the fuse is OK, the lamp will not light, but if the fuse is burned out or removed the lamp will light. When the fuse is in place, the current flows through the fuse because there is less resistance, therefore the lamp will not light. Yet the wire will carry more current than when the fuse is removed and the lamp lights.

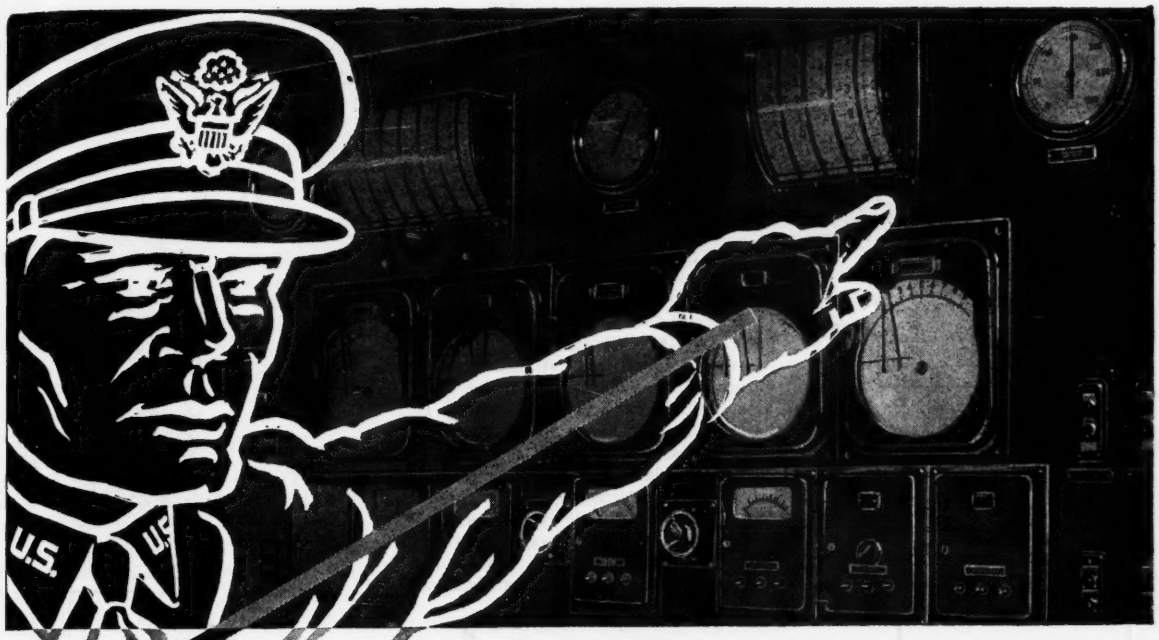
Lombard, Ill. HAROLD D. BROWN

Illustrates Fundamental Ohm's Law

THE QUESTION brings out a fundamental relation of Ohm's Law namely: $E = IR$; so when we decrease R the value of E becomes less, in this case so low it is not sufficient to cause the test lamp to glow visibly. The fact that the test "from area B to ground" does not light does not, as the questioner states, show that there isn't any current flowing but only that the potential (voltage) from "area B" to ground is lower than required to make the lamp filament glow. Or, in a practical way, a ground exists at some point between "area A" and the negative (—) terminal of the generator.

The diagram given can be modified, as in Fig. 1 by indicating the voltages concerned from the generator positive (+) terminal through conductor leading to the load, through the load and then through the return conductor to the negative (—) terminal of the generator. Now neglecting the voltage loss in the generator armature, the generator terminal voltage E_0 equals $E_P + E_{Load} + E_N$; E_P and E_N are very small in comparison to E_{Load} as tests from the generator terminals to the load terminals will indicate.

Now if the system is clear of grounds, a lamp connected to ground from area "A" to area "B" will show no light. The condition will be the same as for a lamp ground indicator as shown in Fig. 2. With the system clear, L_1 and L_2, two lamps in series with the middle connection grounded, will burn dimly with only one-half voltage impressed on the terminals of each lamp. If, then, a ground occurs, say on the negative conductor at point "G", Fig. 2, a divided path will exist between lamp, ground "M" and L—. In other words, L— will have current taken from it and will become dimmer, since the current path has its resistance lowered through the existence of a ground at "G", decreasing the actual return volts for the total current made up of the two paths. Since the current through lamp L+ increases due to the lower return path resistance, it becomes brighter; this is



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a common occurrence with a detector of this type. It follows that with a solid ground at "G", lamp L+ would burn at full brilliancy and lamp L— would be completely dark.

The fact that a test lamp does not burn when connected at area "B" does not indicate there is no voltage to ground as could be determined at once by using a voltmeter instead of a lamp. The condition cited simply shows the existence of a ground at some point between area "B" and area "A" so the current returns to the generator through another path. The two paths in parallel decrease the value of E_N since we have a lower resistance of the two paths together. So by Ohm's Law we have

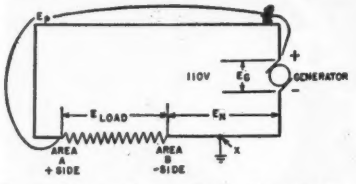

Fig. 1 Diagram by von Dannenberg showing various voltage drops in J. D. T.'s circuit

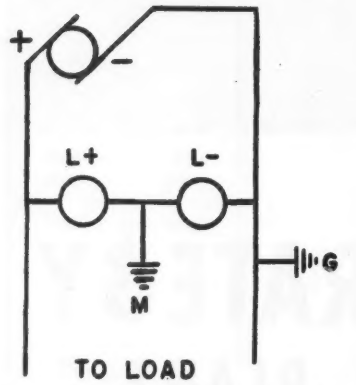

Fig. 2. Diagram by von Dannenberg showing ground indicator connections

$$E_{N1} = I_1 R_1$$

$$E_{N2} = I_1 \times \frac{R_1 R_G}{R_1 + R_G}$$

where E_{N1} and E_{N2} are respectively the voltage drop from area "B" to the generator (—) terminal before and after the existence of ground "G", R_1 is the return conductor resistance from area "B" to the generator with no ground and R_G the resistance of the ground return path to the generator. It is clear $\frac{R_1 R_G}{R_1 + R_G}$, the joint resistance of the parallel return paths from area "B", must be less than R_1; hence the load current flowing through a lower resistance gives a lower drop.

Brooklyn, N. Y. C. O. VON DANNENBERG

Answer No. 271

Which Oil-Burning Method Should He Use?

WHAT's the best way to do it in converting 310-hp Manning boilers (vertical fire tube) from hand-firing with coal to burning Bunker C oil, asked J. L. W. in the September issue?

Darnell Recommends Steam-Atomizing

ANSWERING the question by J.L.W. as to which is the more desirable method for burning Bunker C oil in Manning vertical fire tube boilers, considering cost, efficiency and maintenance, there is little doubt that a steam-atomizing burner with natural draft should be selected.

Obviously a steam-atomizing burner without the necessity of a forced draft fan and ducts will be far cheaper in initial cost. Of course, a mechanical burner can be installed and operated with natural draft, but even without the cost of forced draft the steam-atomizing burner will be much less expensive both as to initial cost and maintenance. It has been my experience that maintenance costs for steam atomizing burners are considerably less than with the mechanical type. Furthermore, if the oil contains any free carbon, even if so fine that it is in a colloidal state, the small orifice in the mechanical burner soon becomes clogged and frequent changing of nozzles is necessary.

There are times, of course, when mechanical atomization should be used. Where make-up water is scarce and must be conserved, such as with ships at sea, mechanical atomization would be more advantageous. Also, in some central stations where steam is produced at high pressures and temperatures, its use in auxiliaries is discouraged.

Small boiler units, however, will generally find steam atomization more economical. As the size of the boiler increases there may be more justification for mechanical atomization. Every proposed installation requires a separate study of all of the variable factors.

Several years ago in a series of tests with steam-atomizing burners and then with mechanical burners under practically the same operating conditions, I found that the steam burners showed higher combustion efficiency i.e. the CO_2 was higher and the overall heat balance gave a higher percentage of efficiency for the boiler with steam burners in spite of the fact that there was some small amount of heat lost in the steam discharged with the products of combustion, which was not present with mechanical atomization. It is unfortunate that I am unable to locate the results of these tests.

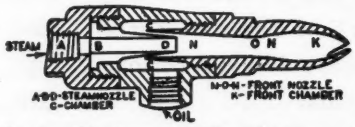

Fig. 1. This steam atomizing oil burner, of the inside mixing type, has high combustion efficiency and low steam consumption, says J. R. Darnell

Separate tests to measure the steam consumption of the steam atomizing type of burner illustrated in Fig. 1 showed that this burner is very economical in steam consumption, using from 0.10 to 0.14 lb steam per lb of oil consumed.

A single burner of the type shown in Fig. 1 could be installed under a Manning boiler, as shown in Fig. 2, at about one-fourth the cost necessary for an installation of a mechanical burner with forced draft and at least one-half the cost even if the mechanical burner is used with natural draft.

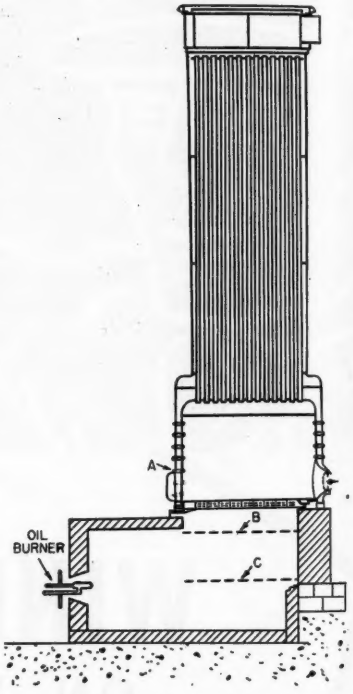

Fig. 2. How a coal (hand) fired, vertical, fire-tube Manning boiler may be converted

In the usual arrangement of the Manning boiler when designed for hand firing, there is a firing door built into the water shell at A, as shown by Fig. 2. The surface of the grate is at the level of the broken line, B. The base of the boiler rests on a circular brick wall about 24 in. high and provided with an ash pit door directly below the firing door. The present ash pit floor is shown by the broken line, C.

In the proposed arrangement of Fig. 2, the grates, ash pit door and about one-third of the circular wall forming the ash pit should be torn out. The present ash pit should then be lowered about 3 ft and a Dutch oven extended out in front of the boiler for a distance of at least 4 ft if space permits. This will permit proper mixing of air with the products of combustion. The steam burner should be installed in an opening (about 12 in. by 12 in.) in the front wall of the Dutch oven. A piece of sheet metal, about 14 in. by 14 in., slotted to fit the steam and oil pipes, should be used to control the air entering around the burner. When the burner is operating at full capacity, this metal plate should be pulled away from the wall as far as possible, so that the required amount of air for complete combustion can be drawn into the furnace with the minimum amount of draft.

Naperville, Ill. J. R. DARNELL

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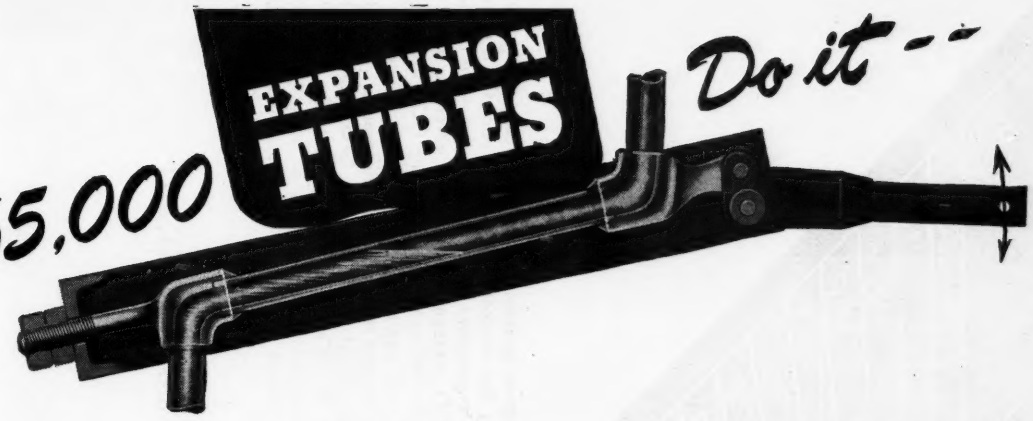
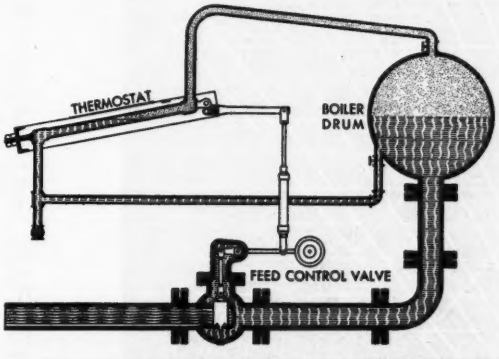


THIS represents the COPES Thermostat—the boiler water level responsive element of more than 65,000 COPES Feed Water Regulators.

Aggressive research for 35 years has failed to uncover any other device as ideal for the purpose.

True, many mechanical improvements have been made. Frequently there are new adaptations to solve specific problems. Several styles are available for different types of COPES Regulators. But fundamentally the COPES Thermostat is still unchanged and unequalled.



• Illustrating how the Thermostat is utilized with one type of COPES Feed Water Regulator—in this instance, a direct operated single element water level control.

How It Operates

An inclined metal tube is mounted between two channels of a rigid steel frame. One end of the tube is anchored to the frame; the other end is attached to an angle type lever.

The interior of the tube is connected to the boiler drum similar to a water column, steam filling the upper part, and water the lower part. Corresponding water levels always exist in the tube and the boiler.

The water filled part of the tube is relatively cool due to radiation. Therefore when the water level lowers, permitting more hot steam to enter, the average temperature of the tube increases. The tube *must* expand. Conversely, with a rise in water level, the tube *must* contract. This movement, amplified by the lever, operates the feed water control valve either by direct mechanical transmission or by pilot valve fluid transmission.

Outstanding Advantages

1. SIMPLE. Just an alloy tube and lever. No floats, stuffing boxes, pressure chambers, liquid charges, fins, orifices, or concealed parts.

2. DEPENDABLE. Utilization of an unbreakable natural law without structural complication.

3. FULLY AUTOMATIC. Repeats performance continuously without periodic attention.

4. POWERFUL. Recall your own experiences with the tremendous forces developed by expansion and contraction.

5. RESPONSIVE. Grasp a pipe and shoot live steam into it. How quickly will you let go? Tests prove the COPES Thermostat responds to level changes 5 to 8 times faster than other devices.

6. ACCURATE. Minute changes in water level cause the tube to react as if by micrometer adjustment. All movement is transmitted smoothly with no lost motion, since working parts are kept in tension by weight or spring loading.

7. STURDY. Built to withstand use and abuse.

8. LONG-LIVED. Usually outlasts the boiler.

9. NON-FOULING. No fins to catch dust or dirt. Condensate keeps interior clean and scale free.

10. ADJUSTABLE. Nuts at the fixed end of the tube permit easy adjustment of water level setting *with the regulator in service.*

11. ADAPTABLE. Performs indoors or outdoors with climatic temperature from —40° to +110°F. Available in all pressure standards and several types to meet space requirements of any installation on land or sea.

Assures Superior Results

The superiority of the COPES Thermostat is just one important reason why COPES Feed Water Regulators provide the maximum of Safety and Economy.

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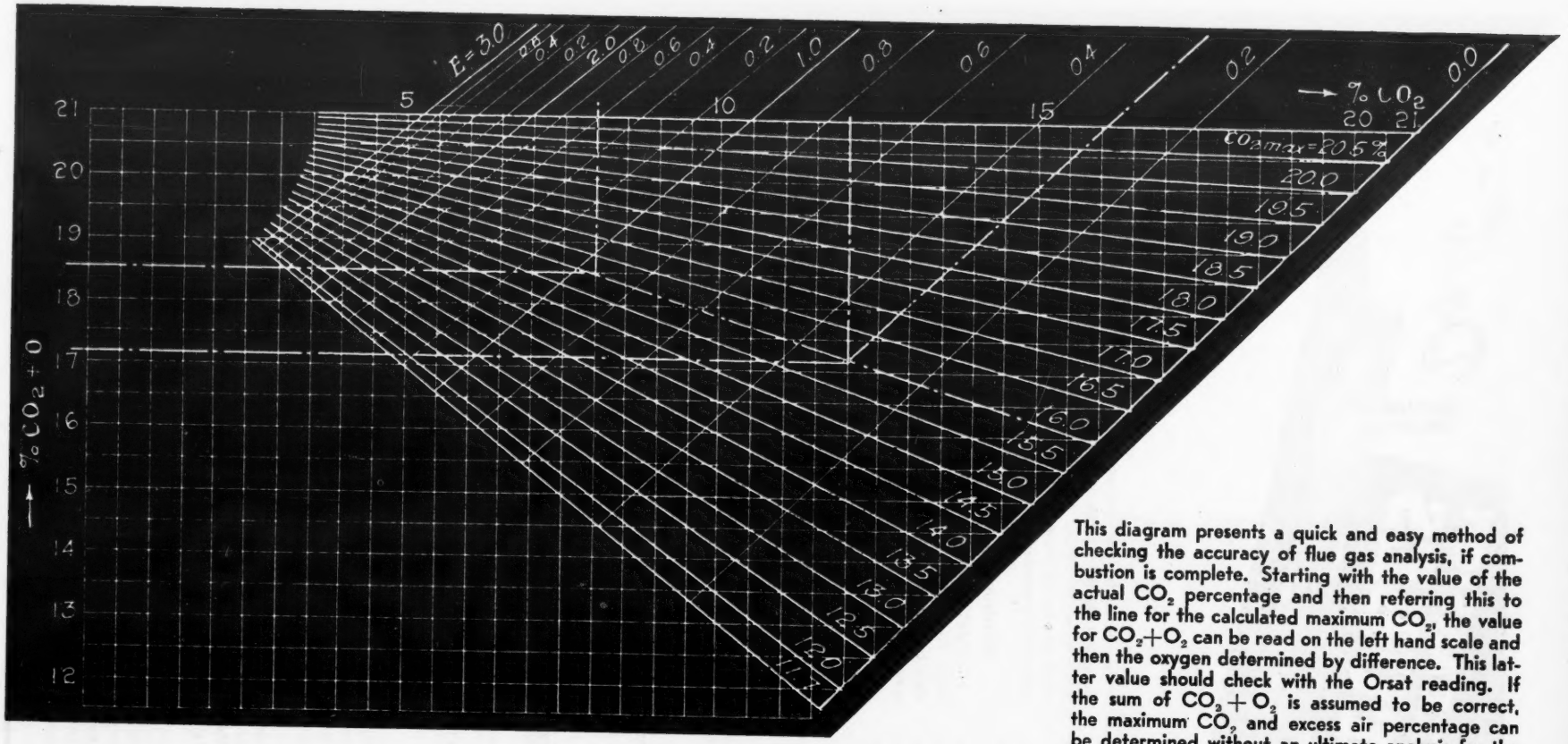

This diagram presents a quick and easy method of checking the accuracy of flue gas analysis, if combustion is complete. Starting with the value of the actual CO_2 percentage and then referring this to the line for the calculated maximum CO_2, the value for CO_2+O_2 can be read on the left hand scale and then the oxygen determined by difference. This latter value should check with the Orsat reading. If the sum of $CO_2 + O_2$ is assumed to be correct, the maximum CO_2 and excess air percentage can be determined without an ultimate analysis for the fuel.

A GAGE FOR CHECKING FLUE GAS ANALYSES (FOR COMPLETE COMBUSTION ONLY)

(See article on p 102 for further explanation)

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Trouble developed frequently under these conditions. The cylinder heads had to be removed every 6 weeks to clean extreme carbon formations and free the two top rings. Wear on cylinders and pistons was excessive.

4 years ago they switched to Solnus Oils on the recommendation of a Sun Oil Engineer. Since no trouble developed, the engines were not taken down at the usual 6-weeks period . . . they were not taken down until a year later. Then they made a surprising discovery. There was only the slightest trace of carbon, all rings were free, and when they calipered cylinders and pistons they found there had been practically no wear!

Continued use proved Solnus Oils exceptional. The annual check-up each year since then has shown the same satisfactory conditions. No shutdowns for any major repairs have been necessary. And these are not new diesels. They are fifteen years old!

Performance like this is typical of Solnus-lubricated diesels. Is it typical of yours? Then investigate these modern, wholly-distilled lubricants that are low in carbon content, neutral in acidity, and durable. Call on a Sun Oil Engineer for recommendations today. Write . . .

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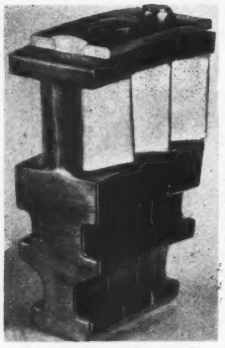

Fig. 4. Impulse blade

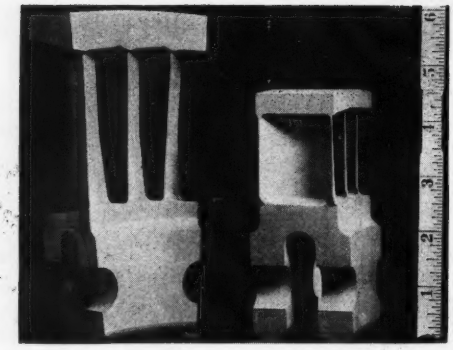

Fig. 5. Turbine blade with "U" shaped roots

speed turbine will before long encroach further on the field of the low speed unit, both with larger exhaust blading development, and possibly also by further compounding of exhaust flows than is now common practice.

The 100,000 kw Burlington Station turbine of the Public Service Electric and Gas Co. of New Jersey, is an example of a 3600 rpm high pressure turbine shown on the left in Fig. 3, operating with steam at 1250 psig 950 F. Throttle valves and steam chests are below the floor. Eight inlet pipes supply steam to the three individual control points of this straight reaction type turbine. From the high pressure turbine, exhaust steam is supplied in parrallel to each of two double flow 3600 rpm units which are arranged in tandem. The crossover piping is below the floor; its pressure was selected to give equal output on each shaft at the combined unit maximum capacity. Normal control is effected by an hydraulic speed governor on the high pressure element; the low pressure shaft has an hydraulic preemergency governor which is set to operate at slightly above synchronous speed but with very small regulation. It controls quick acting pistons to close the main steam chest valves in the event either of electrical separation of the two generators or combined unit overspeeding, making it unnecessary to provide automatic, quick closing valves in the crossover steam piping system.

Turbine Blade Construction

Present heavy duty impulse blade construction is shown by Fig. 4. These blades have double Tee shaped roots, and integral shrouds, and they are joined in groups by a strap secured by riveted tenans. Proportions have been perfected through photoelastic and fatigue testing, resulting in excellent mechanical strength. Optical tests in service have established group vibration characteristics, including their damping capacity, and have established conservative application limits which are safely beyond present demands.

The final step, shown in Fig. 5, was the logical outgrowth of the fundamentals disclosed by extensive research. The individual members of these blade groups are machined to form the steam ports, then they are assembled in groups by brazing the entire surface of adjacent roots and integral shrouds in a neutral atmosphere at about 2200 F. The group is then finish machined to form a "U" shaped root for attachment to the rotor with fitted pins, as indicated. This simple fastening leaves no question as to where the centrifugal load is being carried; natural vibration frequency of the individual groups is not only very high, but also very consistent. Blades of this type have withstood the maximum available test loads with small vibration amplitudes even though the tested blade width was only 75 per cent that of the double Tee type for comparable duty.

The brazing technique has not been fully developed. The problem remaining is to remove any possibility of voids. No group brazed blades will be used until a completely reliable assembly method has been developed.

Standardization

Considerable effort has been given by AIEE and ASME Committees toward the standardization of selected large turbine generator ratings within the field of greatest central station unit capacity, 10,000 to 60,000 kw inclusive. There is now general agreement on all important factors fixing these turbines. They stand as indicated by the chart, Fig. 6, with six individual ratings. It should be noted that for these units the maximum continuous output is 110 per cent of nominal rating, rather than 125 per cent, as has been customary. Correspondingly, nominal ratings for limit frames have been raised, leaving maximum output substantially unchanged. Standard steam conditions have been assigned to reflect going experience and average economies.

As a company we are strongly in favor of standardization as a principle. There are numerous examples in industry, and in the electrical equipment industry especially, where a rational standardization of product has ultimately proved beneficial to user, manufacturer and to the public. At the same time we appreciate thoroughly that to date there has been little practical experience in the standardization of heavy machinery, and its success remains to be proved. We must all recognize that at best, during time of peace, there is no practical possibility of real quantity production in large turbines.

Our large turbine development of the past 10 yr has stressed the standardization of component details and their

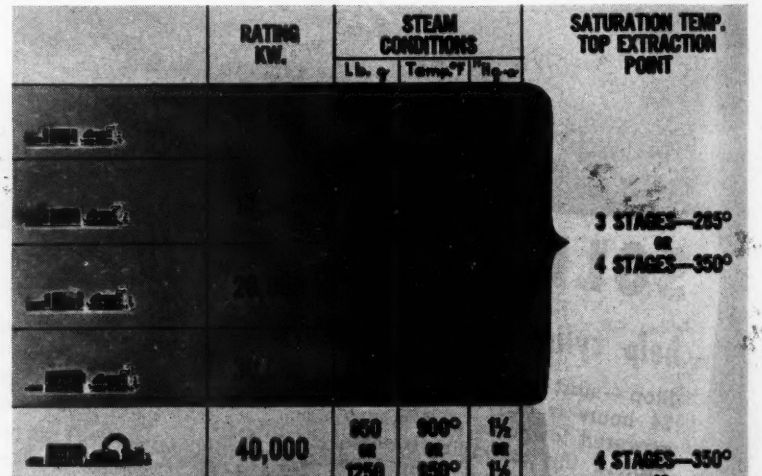

Fig. 6. Probable standard sizes for central station turbines

design principles, such that they could readily be applied, in appropriate size, to any member of a complete line of machines. Important benefits were realized, not only in the expedition of design, procurement of material and in manufacturing operations, but also, field operating experience was then readily translated from a single unit to the line as a whole. This led to more rapid solution of operating problems and the attainment of a high overall level of practical dependability, and undoubtedly helped materially in meeting unprecedented volume demands of a few years ago.

It is our belief that still more can

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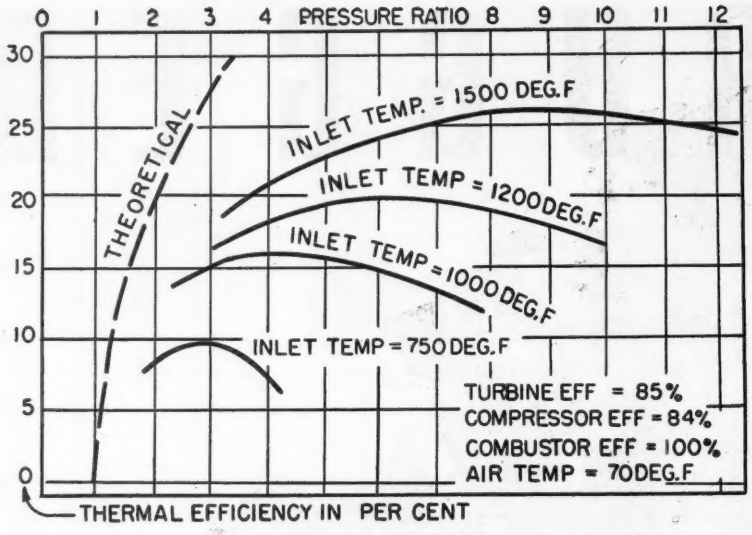

Fig. 7. Effect of gas temperature and pressure on efficiency of gas turbine

be gained along this line by focusing greater attention on a limited number of standard condensing frames after fixing the normal variables of steam and extraction conditions at rational values. We expect that some order of repetitive purchasing can be obtained, and, depending very largely on its extent, that the standard unit will show improved deliveries and prices, and that you will receive thoroughly proved equipment. Deliveries will be materially improved, especially if individual frame activity should become such as to justify the manufacturer carrying a reasonable stock of bottleneck parts if not even of semi-finished machines. Specifically, this could be the means of avoiding serious delay such as may now occur if a larger cylinder casting, or rotor forging, is found defective at some advanced stage of manufacture.

As for the effect on price, we appreciate fully that standardization will fail completely if the price for the strictly standard unit is ultimately not lower than for the tailormade turbine by an amount sufficient to be attractive to you. On the other hand, until there is some reasonable degree of practical acceptance and use, there are in reality no economies to be obtained from standardization. Just how, or when the first step in price adjustment will be made is not our present concern so long as we know that a price differential will come, possibly even before there has been any realistic justification for it.

Some of you have expressed fears that standardization may stifle further steam plant development. This fear is quite groundless.

Gas Turbine Power Plants

We feel that to comment on steam plant development today calls for brief references also to the gas power cycle. As you of course know, several forms of the gas turbine power cycle are being vigorously prosecuted at present, for immediate and early use in applications to which it is particularly well adapted. These applications do not as yet include the primary generation of electrical power, though several popular writers have excited undue optimism in the lay mind that such revolutionary change is at hand. The technical press has been factual, on the whole, and has covered the matter quite thoroughly. You have been given basic data for independent judgment as to just how the gas power cycle may ultimately affect your future plant development.

The principle of the gas turbine power system is very old, but its practical application awaited the development of highly efficient compressors and turbines, and materials that are suitable for service at high temperature. In its simplest form, the power unit consists of a compressor, combuster and turbine, with the generator connected to the shaft at the right, directly or through reduction gearing. The compressor supplies air to the combuster, at from 3 to 7 atmospheres pressure, wherein fuel is burned in direct contact with the air, after which all of the hot gases of combustion expand through the turbine and exhaust at atmospheric pressure. This arrangement is known as the "open" cycle. It is subject to considerable variation, but on the average the turbine will develop approximately 4 units of power, the compressor will consume 3, and 1 power unit is delivered to the generator. The net power being but the difference between two such large values, it is obvious that the net efficiency is critically dependent upon sustained high level of both turbine and compressor efficiency. The compressor delivers 4 to 6 times the amount of air required for fuel combustion alone, so as to limit final combustion gas temperatures to practical limits for available turbine materials.

For maximum efficiency the ratio of turbine inlet pressure to exhaust pressure is low and there is comparatively little heat energy available per pound of gas flow, hence the volumetric flow rate of hot gases through the turbine is very large for even a moderate net output. On the other hand, the combuster, which replaces the customary steam boiler and superheater, operates under several atmospheres pressure with direct mixing of gases, and is relatively small.

Figure 7 gives the approximate relationship between several assumed top gas temperatures and the expected thermal efficiency for the open cycle, and indicates also the effect of gas pressure ratio on overall efficiency for each top temperature.

With a long lived unit now believed practical at about 1200 F, cycle efficiency may be of the order of 19 per cent at a pressure ratio of 6. At the present time we believe the limiting net output of the simple single turbine open cycle unit is about 7500 kw, or even less, this requiring a 30,000 kw turbine with a gas flow of about 750,000 lb per hr. The limit is fixed by practical dimensions of the hot turbine and its blading. If a heat exchanger be used to transfer part of the heat of the hot exhaust gases to the compressed air, again with the 1200 F top temperature, thermal efficiency can be raised to about 26 per cent. If, in addition, we intercool partially compressed air and reheat the partially expanded gas, thermal efficiency of the order of 31 per cent is indicated. Thus, very respectable efficiency level can be obtained for comparison with present leading steam plant practice, but the gas turbine power cycle is then no longer the simple arrangement with which we started. In this cycle we are dealing with pressure ratios which are small compared to those common in steam plant practice; pressure losses in heat exchange apparatus become very serious and inject a major problem in the practical realization of their potential contribution to cycle improvement.

Methods have been disclosed to materially increase the limiting capacity of the open cycle, wherein the system is closed and terminal pressures are pumped up to several atmospheres in order to reduce gas flow volume. Theoretically, this system permits unit capacities to increase many times, and to match most central station steam power unit ratings. Here again, simplicity is further sacrificed. Practical development along this line will await more favorable circumstances.

While the economic future of the simple gas cycle and all of its ramifications is being developed in these more obvious fields of application, it is our plan to vigorously prosecute both steam and gas turbine development. It would be foolhardy to overlook the possible future influence of the gas power cycle in the central station system, but it will be sometime before it could in any event become of practical importance to you.

EXPERIENCE

ex-pe'ri-ence. Trial or test; experiment; demonstration. Knowledge, skill or technic. Practical wisdom. Something attained as the result of trial, observation and use.

Webster's New International Dictionary.

In the field of

INDUSTRIAL WATER CONDITIONING

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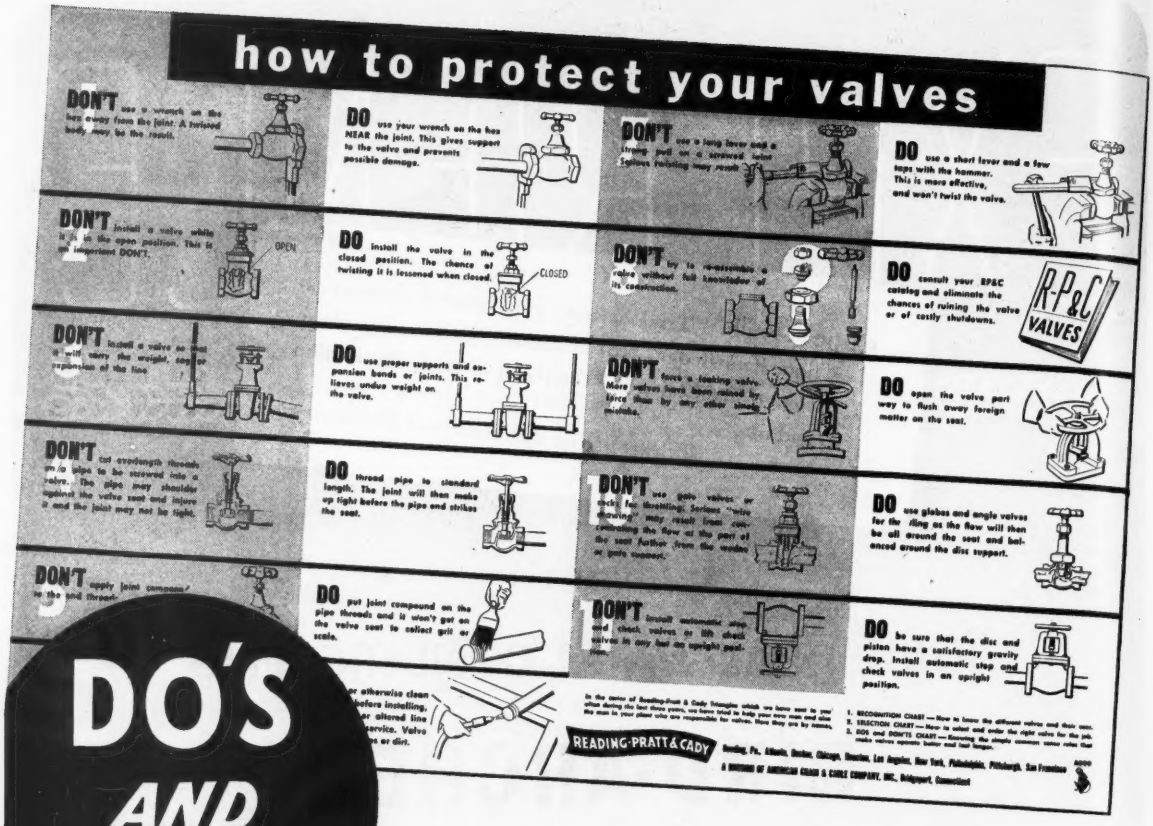
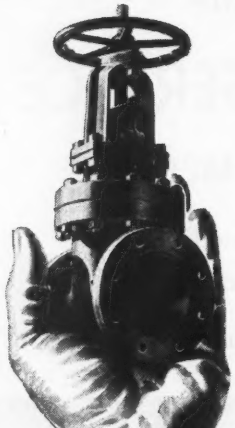

how to protect your valves
DON'T use a wrench on the hex away from the joint. A twisted body may be the result.
DO use your wrench on the hex NEAR the joint. This gives support to the valve and prevents possible damage.
DON'T use a long lever and a strong pull on a screwed valve. Serious twisting may result.
DO use a short lever and a few taps with the hammer. This is more effective, and won't twist the valve.
DON'T install a valve while it is in the open position. This is an important DON'T.
OPEN
DO install the valve in the closed position. The chance of twisting it is lessened when closed.
CLOSED
DON'T try to re-assemble a valve without full knowledge of its construction.
DO consult your RP&C catalog and eliminate the chances of ruining the valve or of costly shutdowns.
R-P&C VALVES
DON'T install a valve so that it will carry the weight, cage or expansion of the line.
DO use proper supports and expansion bends or joints. This relieves undue weight on the valve.
DON'T force a leaking valve. More valves have been ruined by force than by any other single mistake.
DO open the valve part way to flush away foreign matter on the seat.
DON'T cut over-length threads on the pipe to be screwed into a valve. The pipe may shoulder against the valve seat and injure it and the joint may not be tight.
DO thread pipe to standard length. The joint will then make up tight before the pipe end strikes the seat.
DON'T use gate valves or cocks for throttling. Serious "wire drawing" may result from constricting the flow as the part of the seat further from the wedge or gate connect.
DO use globes and angle valves for the throttling as the flow will then be all around the seat and balanced around the disc support.
DON'T apply joint compound to the end thread.
DO put joint compound on the pipe threads and it won't get on the valve seat to collect grit or scale.
DON'T install automatic stop and check valves or lift check valves in any but an upright position.
DO be sure that the disc and piston have a satisfactory gravity drop. Install automatic stop and check valves in an upright position.
READING-PRATT & CADY

DO'S AND DON'TS ...TO MAKE YOUR VALVES SERVE YOU *BETTER-LONGER*



This is the third of the series of charts developed by Reading-Pratt & Cady as a service to the valve users of the nation. Like the other two—How To Know Valves and How To Select Valves—this one, How To Protect Your Valves, will serve as a reminder to experienced men and as invaluable information to new men in industry. It tells in pictures and simple, non-technical language how to avoid the mistakes that shorten the life of valves—how to get maximum service from them.

For copies of this chart, address our offices in Reading, Pennsylvania. There's no charge, of course.

READING-PRATT & CADY

MANUFACTURERS OF

READING CAST STEEL VALVES AND FITTINGS • PRATT & CADY BRASS AND IRON VALVES
D'ESTE VALVE AND ENGINEERING SPECIALTIES

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A DIVISION OF AMERICAN CHAIN & CABLE COMPANY, Inc., BRIDGEPORT • CONNECTICUT

A Compact Power Supply Right Where It's Wanted

Close to the load, yet out of the way

- ✓ NO OIL
- ✓ TOTALLY METAL ENCLOSED
- ✓ NO FIREPROOF VAULTS
- ✓ REMOTE MOUNTING UNNECESSARY
- ✓ NO LONG RUNS OF HEAVY COPPER

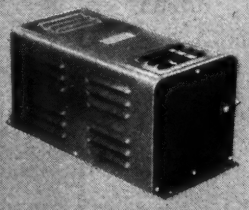
TUCKED AWAY UNDER THE EAVES at Kaiser Cargo, Inc., Shipyard No. 4, this 25-kva G-E dry-type transformer takes power from a 440-volt circuit and steps it down to operate 110- or 220-volt electric hand tools and lighting circuits, close by. The inherent safety that permitted it to be placed close to the load eliminated the need of long runs of heavy, expensive copper.

Installed right at the load, Type D transformers provide your equipment with the right voltage for its most economical operation. They are being used, profitably, from coast-to-coast in industrial plants to insulate one circuit from another and to boost or step down voltage for the most efficient operation of such equipment as motors, machine tools, welding apparatus, heat-treating furnaces, and high-current testing devices.

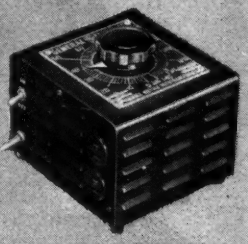
Stay cool; save space—Type D transformers are cooled by natural-draft ventilation. Their unique, drip-proof case, which incorporates a slanted-louver construction, aids the flow of ventilation air through the transformer coils. They can be placed against a wall or close to other units, with little or no effect on the temperature rise of the transformer. Because of this fact, considerable space can often be saved, especially when a number of these transformers are to be banked.

Easy to install; maintenance negligible—As these transformers are small, compact, and lightweight, they are easy to install on the floor, on the wall, or anywhere you wish. Either conduit or open wiring can be used. The ease of disassembly and reassembly of case parts permits quick inspection and cleaning, when necessary. But operating records show that little or no maintenance is required. Type D transformers are available in ratings up to 100 kva, 600 volts. For further information, ask for Bulletin GEA-897. *General Electric Company, Schenectady 5, N. Y.*

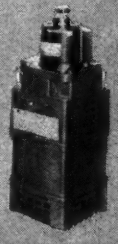
OTHER G-E AIDS TO BETTER VOLTAGE



VOLTAGE STABILIZER—Automatically provides a constant 115-volt supply to a given load, on circuits varying from 95 to 130 volts. Ratings from 50 to 5000 va. Ideal for precision laboratory or manufacturing processes, or built into such equipment as radio transmitters.



VARIABLE-VOLTAGE AUTO-TRANSFORMER—Provides smooth, adjustable control of voltage, current, light, temperature, power, and speed at a turn of the dial. Ratings from 243 to 810 va. Ideal for use in factories, laboratories, and assembled with other equipment.



AIR-COOLED REGULATORS—Automatic type: for secondary circuits (10% regulation, raise and lower). Remote-motor or hand operated: for laboratory or testing (100% raise and lower). Ratings up to 12 kva, 600 volts.

THE RIGHT VOLTAGE AT THE RIGHT PLACE DOES THE JOB **BETTER**

GENERAL ELECTRIC

- **RELIABILITY**
- **STRENGTH**
- **ECONOMY**
- **SAFETY**

. . . characteristics of every **KENNEDY** *valve*

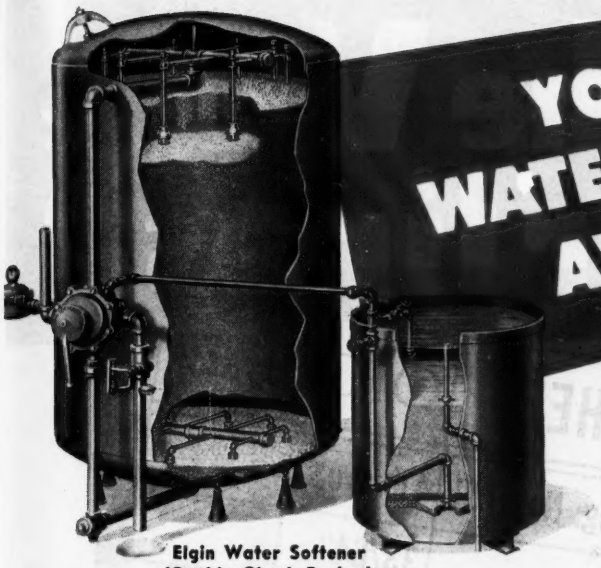
Kennedy Valves are reliable because of their simple, sturdy and effective operating mechanisms. Many of these mechanisms were originated by Kennedy, and have proven their effectiveness in thousands of installations.

These valves are economical because of their durability which has been demonstrated by decades of service in many installations without maintenance expense.

Their generous proportions of all parts, together with high-quality, high-tensile-strength metal, assure ample strength and complete safety. You are always safe with Kennedy "Extra Value" Valves.

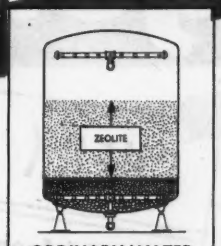
THE KENNEDY VALVE MFG. CO.
ELMIRA • NEW YORK

KENNEDY *valves . . . pipe fittings . . . fire hydrants*

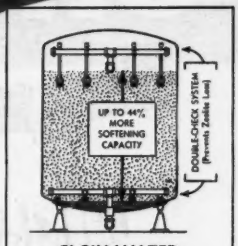


Elgin Water Softener
(Double Check Design)

YOUR POSTWAR WATER SOFTENER IS AVAILABLE NOW



ORDINARY WATER SOFTENER DESIGN



ELGIN WATER SOFTENER DESIGN

The New Elgin Water Softener

- **GIVES UP TO 44% MORE SOFT WATER**
- **PREVENTS LOSS OF ZEOLITE**
- **CUTS SALT CONSUMPTION**
- **ASSURES BETTER BACKWASHING**

WHEN it comes to zeolite water softener equipment you don't have to take the "wait-for-something-better-after-the-war" attitude. That something better is here—and is *available now.* It's the new "Double Check" design water softener. A long list of users fully confirm the fact that this water softener gives 44% more soft water than can be secured from any other unit of equal size.

One of the chief reasons for this increased capacity is diagramed above. The new "Double Check" manifold arrangement permits placing a far greater amount of water softening zeolite in the softener, as shown. More zeolite means more soft water output, for after all, it's the zeolite that softens water. This ingenious manifold also permits the zeolite to be washed cleaner and prevents packing and channeling of the bed. Brine reaches every portion of the zeolite, giving complete, efficient regeneration with lower salt consumption. All this is accomplished without the possibility of zeolite loss. Here truly is tomorrow's water softener today.

The whole story is told in our new bulletin 603. *Write for it today.*

HERE'S HOW TO STEP UP THE CAPACITY OF YOUR PRESENT WATER SOFTENER

The "Double Check" manifold arrangement can be quickly installed in place of the ordinary manifold in your present water softener regardless of make. This, along with Elgin High-Capacity Zeolite, will give you greatly increased soft water output. The cost of such modernization is surprisingly low. Ask for facts.

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ECONOMICAL WATER CONDITIONING

THE COMPLETE ELGIN LINE—Boiler Water Treating and Purifying Systems • Feedwater Treatment • Deconcentrators • Heat Exchangers • Water Softeners • Filters and Purifiers • Iron Removal Equipment • Aerators • Water Treating Chemicals • Chemical Feeders • Scale and Corrosion Inhibitors • Sample Coolers • Water Testing Equipment • Zeolites

ELGIN SOFTENER CORPORATION, 136 North Grove Ave., Elgin, Illinois

What's the V.Q.* on your lines?

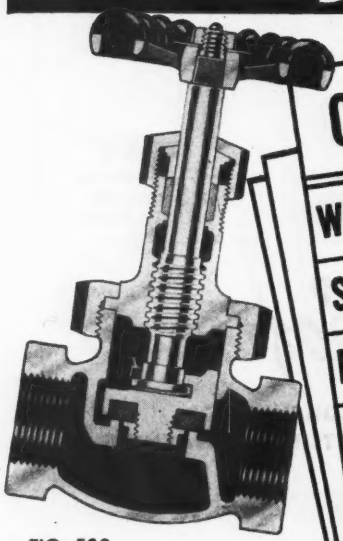


FIG. 520

CHECK SHEET	OIC	OTHER
WEIGHT 1-Inch Fig. No. 520	4 lb. 5 oz.	
STEM DIAMETER	33/64"	
END-TO-END MEASUREMENT	3-7/8"	
DIAMETER OF HEX (Across Flats)	1-13/16"	
WIDTH OF HEX	9/16"	
WEIGHT OF DISC & DISC HOLDER	4-1/2 oz.	
WEIGHT OF BONNET NUT	8-3/4 oz.	
DIMENSIONS OF CONDENSING CHAMBER	13/16" Dia. 27/64" Deep	
STEAM RATING	200# WSP	
LIST PRICE	$6.60	
V. Q.		

What's the Valve Quotient on your steam, water, oil and gas lines?

Take, for example, a one-inch Union Bonnet composition disc Globe valve-OIC Fig.No.520.

With this valve your V. Q. is higher than with other valves . . . on steam working pressure rating, it is 133%.

Prove it to yourself. On this handy check sheet, showing OIC specifications, just make the comparison.

There is an OIC Distributor near you, ready to help you check your V. Q. Call him or write us for details on OIC Bronze, Iron and Steel Valves.

*VALVE QUOTIENT

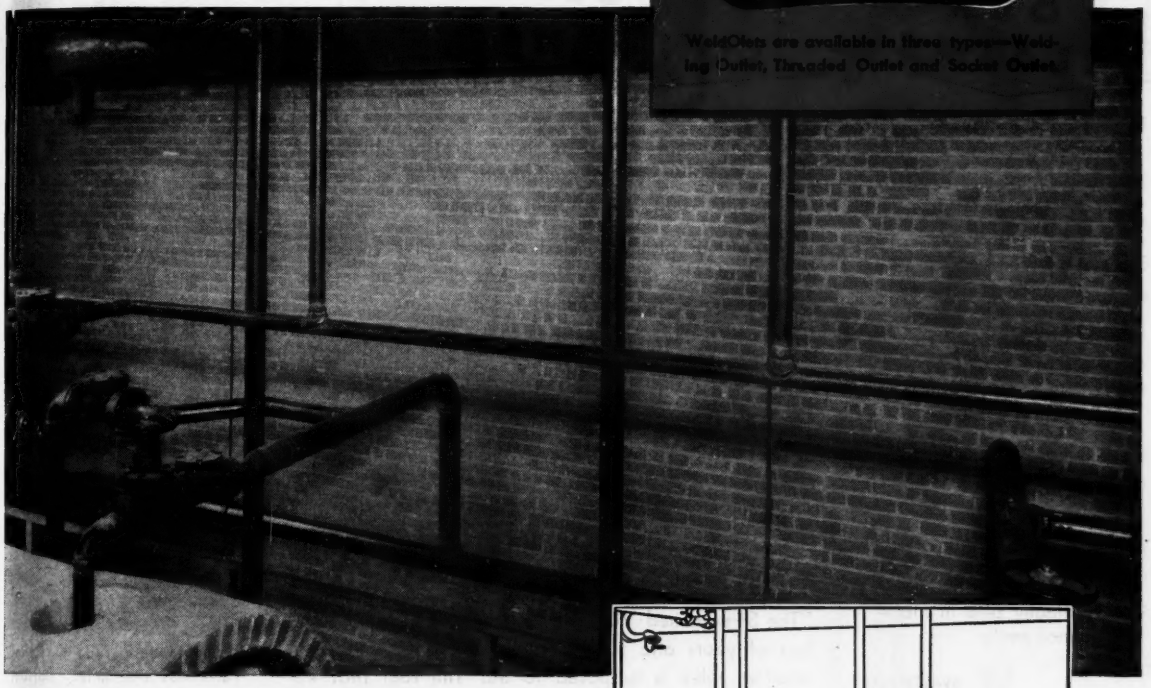
ARMY E NAVY

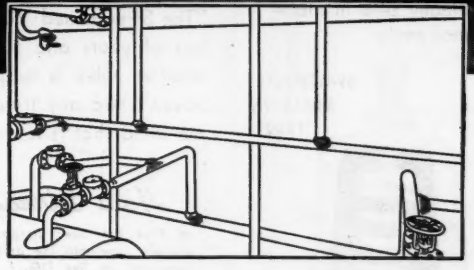
THE OHIO INJECTOR COMPANY
WADSWORTH, OHIO
Quality Leaders in Valve Manufacture Since 1883

OIC

How To Maintain FULL PIPE STRENGTH At Branch Outlets

WeldOlets are available in three types—Welding Outlet, Threaded Outlet and Socket Outlet.





In a pipe job like this, branch pipe outlets must maintain the strength of the original pipe to insure safe, permanent, leak-proof joints. This is done easily by the WeldOlet method. These drop-forged fittings are shaped to fit the run pipe and are designed to provide ample reinforcement at the joint for pressures up to 400 lb. at 750° F. The factor of safety, under internal pressure, is equal to that of the pipe itself.

In addition, the scientifically designed funnel shaped opening of the WeldOlet permits unobstructed flow and a minimum of pressure loss due to turbulence and friction.

WeldOlets are available in size-to-size and reducing sizes from ¼" to 24". For information on the complete line, send for Catalog.

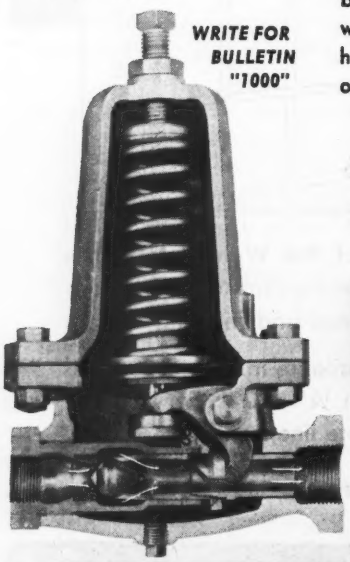
Forged Fittings Division • BONNEY FORGE & TOOL WORKS • 639 N. Meadow St., Allentown, Pa.

WELDOLETS
TRADE MARK REG. U. S. PAT. OFF. PAT. IN U. S. & FOREIGN COUNTRIES
WELDING OUTLET - THREADED OUTLET - SOCKET OUTLET
For Welded Branch Pipe Outlets

CASH STANDARD Streamlined PRESSURE REDUCING VALVE TYPE 1000

OUR CLAIMS

1. Maximum Capacity when needed most
2. Accurate Pressure Control under toughest working conditions
3. Trouble-free Service
4. Smooth Operation
5. Tight Closure
6. Accurate Regulation
7. Speedier Production Results
8. Elimination of failures
9. Constant Delivery Pressure
0. Cost Saving Operation
1. No Spoilage
2. Practically zero in maintenance costs



WRITE FOR BULLETIN "1000"

USER CONFIRMATION

"We could not afford to have pressure build up because of low pressure equipment. When we started to use the '1000' our troubles stopped."

"One of our plants needed a good valve for close control on fuel oil. This valve has given fine service and has never been touched for any reason."

"We use the '1000' because of the lack of attention needed to keep it operating in first class shape."

"I wanted a valve that would give close control on delicate work in our seed laboratory. Holding air pressure on this spot was not so easy. Needless to say our experience with the '1000' valve has been 100%."

"These '1000' valves don't let the pressure go all over the map but hold the pressure constant."

"The Streamlined '1000' valve has been in for a number of years and to our way of thinking, it's doing what a valve is supposed to do. The fact that we haven't had any trouble with this regulator brings to our mind that it is worth all we paid for it."

How Streamline Design Works

● Flow has been streamlined for straight flow into the delivery passage and jet. See FIG. 1. The fluid

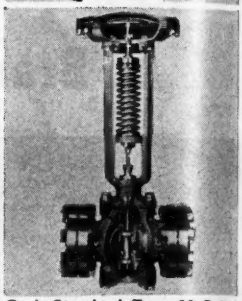
FIG.-1

flows smoothly around this valve with no back eddies to cause turbulence, See FIG. 2, on the downstream side of its trailing edge. In a reducing valve all the pressure drop or work of pressure reduction should occur at one place, namely where the valve throttles flow, and not on the downstream side of the valve. Where you have downstream turbulence, See FIG. 2, the greatest amount of turbulence with resultant greatest pressure drop will occur when you want maximum flow and therefore want least pressure drop—if the delivery pressure is to be maintained. With

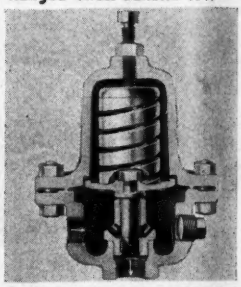
FIG.-2

Streamlined Flow, See FIG. 1, you get maximum capacity, plus close delivery pressure control.

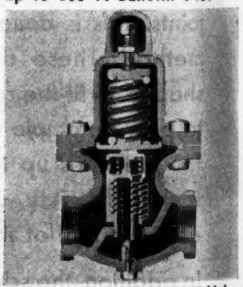
OTHER VALVES *from the* CASH STANDARD LINE



Cash Standard Type 33 Relief Valve; in various metals to handle nearly all fluids. Has Roller guides on valve spindle; also roller bearing to take care of spring torsion. Sizes ½" to 3" screwed ends; 1" to 12" flanged ends. Bulletin 971.



Cash Standard Type Q Relief Valve has side inlet, bottom outlet. Popular for pump bypass use. Sizes ½" to 2" screwed ends. Relief pressures up to 350 lbs., temperatures up to 500°F. Bulletin 943.



Cash Standard Type 4190 Valve for relief (bypass) use; holds constant valve inlet pressure regardless of changes in load or outlet pressure. Multiport—large capacity. Iron or bronze bodies; iron or bronze trim. Sizes ½" to 2" screwed ends; 2" to 6" flanged ends. Bulletin 952.

☆

CASH STANDARD CONTROLS.. VALVES

A. W. CASH COMPANY
DECATUR, ILLINOIS

Inside information on POWELL VALVES

From the outside, this small size 200-pound "White Star" bronze Globe Valve looks very much like the same type of valve in other makes. But inside, where it really counts, Powell design and engineering show the results of nearly a century of "know how" in Valve making.

Among its many features are the regrindable and renewable semi-cone plug type seat and disc, especially designed for severe service conditions. The disc is made of "Powellium," a special nickel-bronze alloy developed by Powell Engineering. The seat ring is furnished in a specially heat treated Stainless Steel. Both are highly resistant to corrosion and erosion.

Of interest, particularly to maintenance men, is the fact that this valve can be *repacked under pressure* when wide open. This feature is provided by the machined face on the base of the bonnet which, engaging with the cut-off collar machined on the top of the disc lock nut, positively seals off the pressure from entering the bonnet. An exceptionally wide and deep stuffing box affords generous packing space. The protruding gland, held in place by a large stuffing box nut, also affords an additional guide for the stem.

The ground joint union body-bonnet connection, held fast by a heavy hexagonal ring nut, permits the bonnet to be easily and quickly removed from and re-attached to the body any number of times without impairing the tightness of the connection.

Ample space between the end of the pipe thread and the diaphragm prevents the pipe striking the diaphragm and distorting the seat when screwing the pipe into the body.

The malleable iron *non-heating* handwheel is designed to fit the hand and afford ease in operating the valve.

The complete POWELL Line includes Globe, Angle, Gate, Check, Relief, Y, Non-Return and other types of valves in bronze, iron, steel, pure metals and special alloys to meet the demands of all branches of industry for dependable flow control equipment.

The Wm. Powell Co.

Dependable Valves Since 1846

Cincinnati 22, Ohio

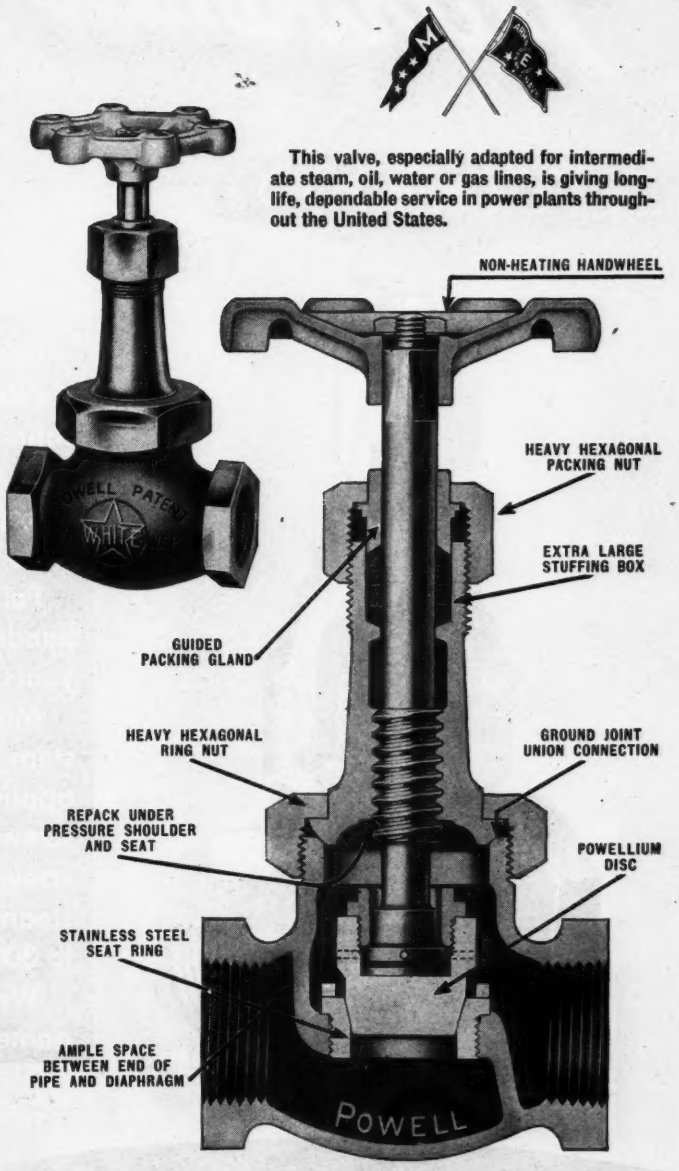
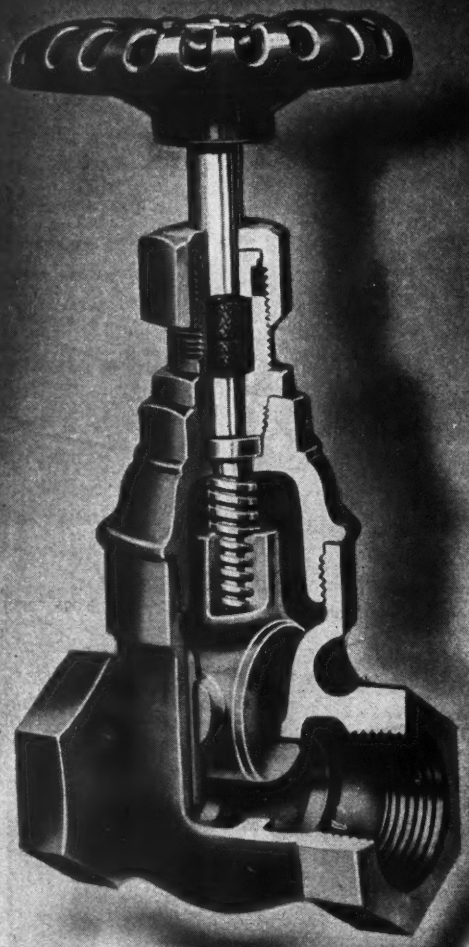

This valve, especially adapted for intermediate steam, oil, water or gas lines, is giving long-life, dependable service in power plants throughout the United States.
NON-HEATING HANDWHEEL
HEAVY HEXAGONAL PACKING NUT
EXTRA LARGE STUFFING BOX
GUIDED PACKING GLAND
HEAVY HEXAGONAL RING NUT
GROUND JOINT UNION CONNECTION
REPACK UNDER PRESSURE SHOULDER AND SEAT
POWELLIUM DISC
STAINLESS STEEL SEAT RING
AMPLE SPACE BETWEEN END OF PIPE AND DIAPHRAGM
POWELL PATENT
WHITE
POWELL

Fig. 1708
BRONZE "WHITE STAR" GLOBE VALVE

POWELL VALVES

Fairbanks Valves



Fairbanks Bronze Gate Valves are designed so that the wedge is entirely removed from the line of flow when fully open. They can be repacked under pressure when wide open.

Fairbanks Valves can be depended on for the maximum in years of useful, carefree service.

Made in non-rising and rising stem types for practically every application; also with outside screw and yoke. Available with screwed or flanged ends for steam working pressures of 125 to 300 lbs.

Write for Catalog No. 42 and name of our nearest distributor.

THE FAIRBANKS COMPANY

393 Lafayette St., New York 3, N. Y.
520 Atlantic Ave., Boston 10, Mass.
15 Ferry Street, Pittsburgh 22, Pa.

IN THREE YEARS

. . . NO MAJOR REPAIRS

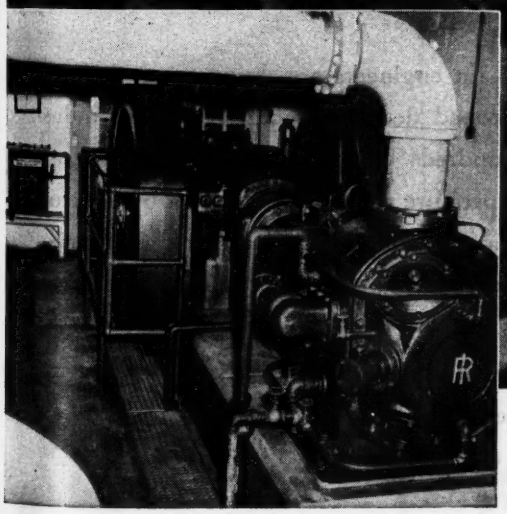
. . . NO OIL CHANGE NECESSARY

. . . OIL CONSUMPTION CUT MORE THAN 75%

. . . NO BREAKDOWNS BECAUSE OF DIRTY LUBE OIL

Municipal Water Works at Findlay, Ohio, where the engineer in charge reports these amazing facts about the Briggs installation.

BRIGGS OIL CLARIFIER runs up high performance record on this Ingersoll-Rand Horizontal Oil Engine



The Ingersoll-Rand Horizontal Oil Engine that drives an Ingersoll-Rand Air Compressor. The Briggs D-2-AX Oil Clarifier has been in service for three years. This unique installation (note pump interconnected with fly wheel) permitted installation of the Clarifier independent of the engine lubrication system.

This installation shows what Briggs Oil Clarifiers can do toward securing maximum economy and efficiency for your industrial engines . . . regardless of their size or type.

Consult the Briggs distributor nearest you and get his expert recommendations regarding the Briggs Oil Clarifier that will solve your oil filtration problem . . . give new economies in operation and longer, more efficient life for your engines.

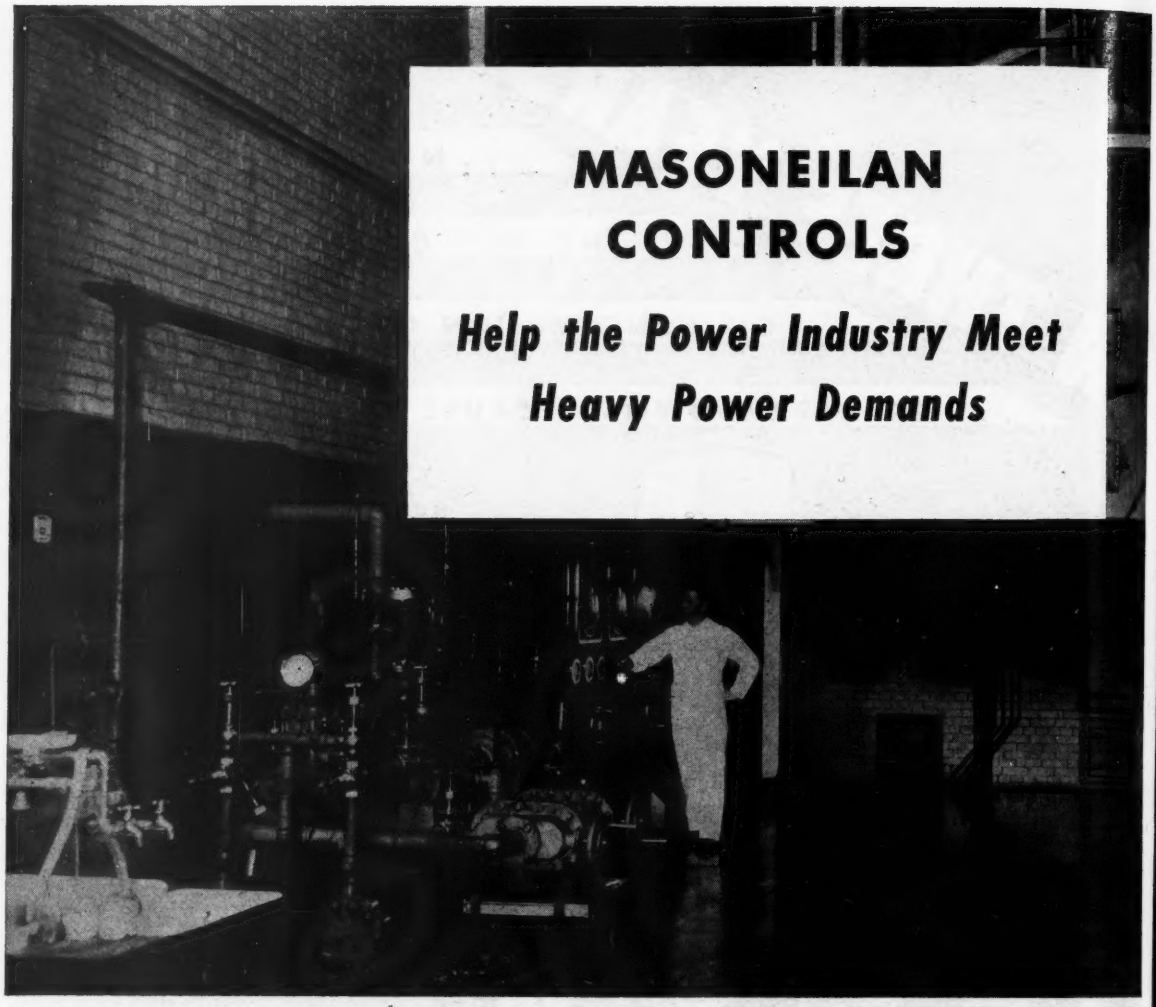
Briggs

PIONEERS IN MODERN OIL FILTRATION

BRIGGS CLARIFIER COMPANY

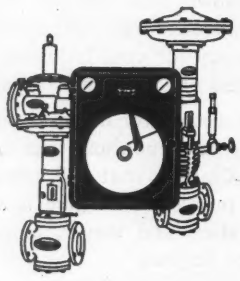
GENERAL OFFICES, WASHINGTON 7, D. C.

DISTRIBUTORS IN PRINCIPAL CITIES



MASONEILAN CONTROLS

Help the Power Industry Meet Heavy Power Demands



TODAY, power plant engineers are doing a great job in meeting the peak-load demands required by war industries . . . And in hundreds of plants, Masoneilan Control Equipment—such as pressure regulators, temperature controllers, flow meters, indicators and recorders—is helping by providing accurate, reliable and dependable control under all operating conditions.

A portion of our equipment is now available for maintenance and replacement for other than war industries. Write for information and catalog 71.

MASONEILAN

MASON-NEILAN REGULATOR COMPANY

1207 ADAMS STREET, BOSTON 24, MASS.

New York Philadelphia Pittsburgh Toledo Chicago Tulsa Atlanta St. Louis Houston
Los Angeles San Francisco Mason Regulator Co. of Canada, Ltd., Montreal, Canada

Scovill Tube News

Vol. 2 SCOVILL MANUFACTURING COMPANY, Waterbury 91, Conn. No. 6

New Booklet Tells How To Get Most Out Of Tubes

Scovill's "Condenser Tube Booklet" has important facts for operators of condensers and heat exchangers

Here are 56 pages of useful information on many of the important factors relating to condenser and heat exchanger tubes. Among the subjects covered are:

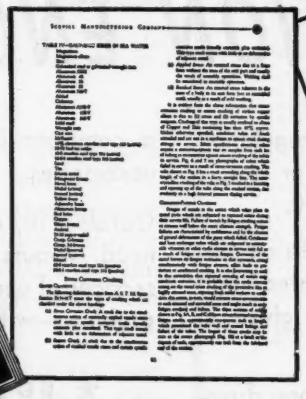
- Tube Corrosion: types (with characteristic specimens illustrated in natural color), causes and methods of protection
- Selection of Tube Material
- Composition and Properties of Tube Alloys and Common Metals
- Installation Methods
- Specifications
- Methods of Production

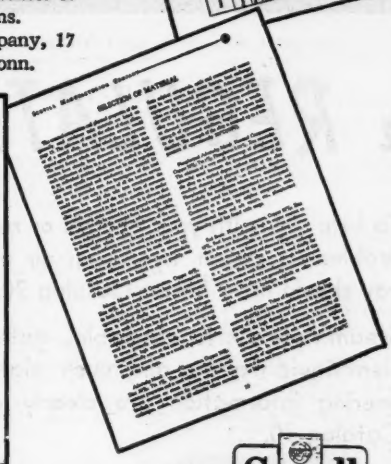
Also included are discussions of the extrusion process and the hot piercing process, and such useful data tables as those on gauge sizes, conversion factors, formulas and physical constants, etc.

THIS BOOKLET ILLUSTRATES 1 OF 3 SCOVILL SERVICES

Scovill considers that its responsibility to power plant operators, embraces not only tube *manufacturing*, but also *information* and *service*. Information such as is found in the new "Condenser Tube Booklet" is part of Scovill's *Service in Manuals*. A second service is *Service in Metals*, which includes the development of new or improved tube alloys and the analysis of problems arising from tubes in service. The third Scovill service, *Service in Men*, makes Scovill's technical experience available through individual recommendations for specific requirements — helping you obtain maximum efficiency from your condenser or heat exchanger tube installations.

Scovill Manufacturing Company, 17 Mill Street, Waterbury 91, Conn.





ARMY E NAVY

THIS IS NUMBER TWELVE in a Series of Scovill Advertisements to help you get longer life from condenser and heat exchanger tubes.

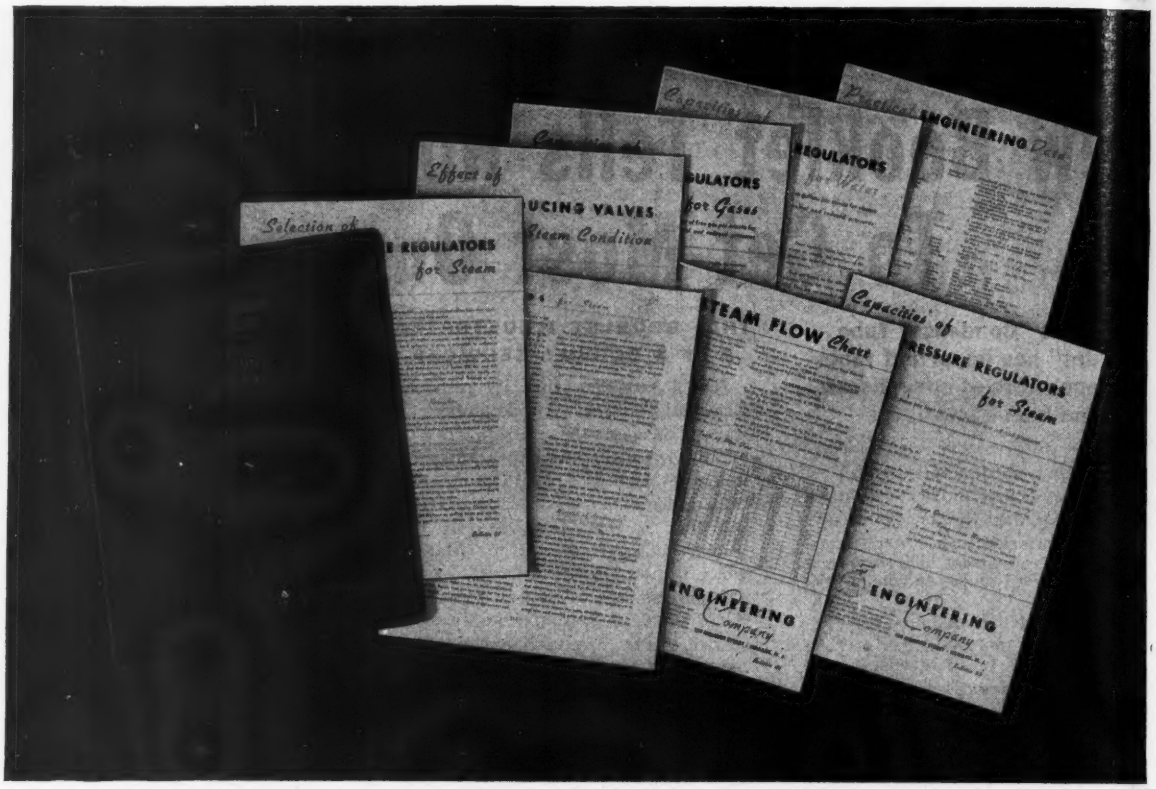
Scovill
MANUFACTURING COMPANY
WATERBURY, CONN.

SCOVILL CONDENSER TUBES

ONE PRODUCT... THREE SERVICES

Service in Manuals... Service in Metals... Service in Men

FOSTER *FACTS and INFORMATION*



on REGULATION ENGINEERING

To help you with your control or regulation problems...steam, hydraulic, air or gas... you should have Foster Catalog 70.

Steam flow charts, gas tables, data on efficient liquid transfer and much related engineering information are clearly given in Catalog 70.

In addition, you will find descriptions, drawings, specifications and operating data on a complete line of regulating valves and accessories.

Catalog 70, requested on company letterhead, is yours for the asking. And so are the services of our engineering staff—for special problems—without obligation.

★ **BUY WAR BONDS** ★

FOSTER ENGINEERING *Company*

PRESSURE REGULATORS...RELIEF AND BACK PRESSURE VALVES...AUTOMATIC STOP AND CHECK VALVES...ALTITUDE VALVES...DAMPER REGULATORS...FAN ENGINE REGULATORS... PUMP GOVERNORS...TEMPERATURE REGULATORS...LIQUID LEVEL CONTROLLERS...FLOAT AND LEVER BALANCED VALVES...NON-RETURN AND TRIPLE DUTY VALVES...VACUUM REGULATORS OR BREAKERS...SIGHT FLOW BOXES...STRAINERS...SAFETY VALVES...SIRENS

111 MONROE STREET • NEWARK 1, N. J.

11-FE-3

FLAMENOL

Simple test demonstrates value of G-E synthetic cable

Before you install wiring in a location where there is danger of fire, *first* make this test:

Light a match, and hold a piece of Flamenol* wire in the flame. Use several matches, one after another. The insulation will char, but it will *not* burst into flame. Therefore, Flamenol gives you this assurance: If fire *does* break out, *it will not be spread by the wiring.*

Flamenol Has Proved Itself

The insulation on Flamenol wire and cable is *not* a newly developed and temporary substitute. Designed to overcome the disadvantages inherent in other insulations, it has been in commercial use more than *eight years.* Its many advantages, listed at right, have been proved under severe conditions of service in thousands of industrial installations.

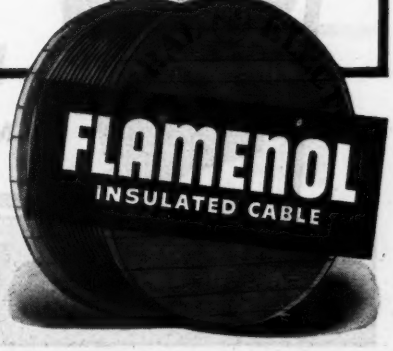
As a result of thorough tests carried out over long periods of time, many of the country's leading chemical, oil, automotive, and other companies changed to Flamenol long before the rubber shortage. For further information, constructions, suggested uses, etc., write to the nearest G-E office. *General Electric Company, Schenectady, N. Y.*

*Reg. U.S. Pat. Off.

12 BIG ADVANTAGES offered by FLAMENOL

1. FLAME RESISTANCE—does not support combustion.
2. CORROSION RESISTANCE—immune to action of oils, acids, alkalies.
3. SUPER-AGING — does not oxidize. Highly resistant to sunlight and weathering.
4. EXCELLENT PHYSICAL PROPERTIES—has minimum tensile strength of 1500 lb per sq in., minimum elongation of 100 per cent.
5. DIELECTRIC STRENGTH—retained at about 720 volts per mil through severe operating conditions.
6. SMALL DIAMETER—saves space, facilitates wiring.
7. SMOOTH SURFACE—facilitates pulling through conduit.
8. FREE STRIPPING—speeds splicing, avoids nicking conductors.
9. DIFFERENT COLORS—simplify circuit tracing.
10. VARIOUS CONSTRUCTIONS—aid selection for special applications.
11. SELF-PROTECTING FINISH — eliminates need for braid, less space required.
12. ATTRACTIVE APPEARANCE—is maintained through long service, painting is never needed.

BUY WAR BONDS



GENERAL ELECTRIC

I'd rather have my valves

DEXTER-RESEATED

than break in new ones

Here's why . . . An old valve is "comfortable" — like an old pair of shoes. It has worked into its job: None of that s-t-r-e-t-c-h and take-up that seems to unsettle a new valve on the line . . . the old fellow is a part of the system — you can depend on him.

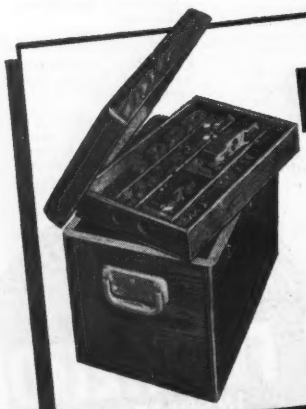
When it leaks, you're better off if you reseat the valve right on the line. Just remove the bonnet and put in a Dexter Valve Reseating Machine. Make a few adjustments — turn the crank a few times — and you've got a clean-cut seat that's actually better than new. Now reface the disc and put it back in the valve, and your old friend is ready to carry on.

Personally, I'd go a long way to save an old valve — but by reseating with a Dexter Outfit I also save time, avoid costly shutdowns, and don't have to buy a new valve — which isn't always easy these days.

What's your valve leak problem?

Just drop us a line, giving us the make, type, size and material . . . whether water, air or steam, and the pressure. We'll give you the Dexter answer to your problem and suggest the proper Dexter Valve Reseating Outfit for you.

13



DEXTER VALVE RESEATING MACHINES AND CUTTERS

FOR GLOBE, GATE AND PUMP VALVES

THE LEAVITT MACHINE COMPANY
ORANGE, MASSACHUSETTS

TRICK SHAPE FOR A [illegible] TO TAKE

★ *It's easy, though not economical, to forge a piece of solid metal to the external shape of a tee like this, and then bore the run and branch. But to start with a seamless tube, form the long outlet, and at the same time maintain full wall thickness and adequate reinforcement, is quite a different matter.*

Taylor Forge tackled this problem a good many years ago and made the first seamless welding tees having outlets of ample length. The methods for doing this production job can also be used to make unusually long outlet tees such as the "special" pictured here. We have never seen another like it. Have you?

ACROSS the years, when the question has been, "Who can handle this difficult forging requirement?", industry's verdict has almost invariably been Taylor Forge. It is a verdict based on a great and ever-growing volume of evidence, just a few examples of which are being cited here.

This recognized "know-how"—this conceded knowledge of how to control hot metal under pressure and impact—has a highly important bearing on our standard line of WeldELLS, tees and other Taylor Forge Welding Fittings.

It is this broad knowledge, and the special processes springing from it, that enable us to give you so many *extra* features in WeldELLS and other Taylor Forge Welding Fittings. It explains why we can control the distribution of metal—place extra metal where stresses are greatest. It explains the extreme accuracy of dimensions . . . the absolute uniformity. It explains why WeldELLS have the features listed opposite . . . why, in fact

WeldELLS alone combine these features:

- **Seamless** — greater strength and uniformity.
- **Tangents**—keep weld away from zone of highest stress—simplify lining up.
- **Precision quarter-marked ends**—simplify layout and help insure accuracy.
- **Selective reinforcement** — provides uniform strength.
- **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum**—assures full strength and long life.
- **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World** — insures complete service and undivided responsibility.

WeldELLS have everything

TAYLOR FORGE & PIPE WORKS, General Offices & Works: Chicago, P. O. Box 485
New York Office: 50 Church Street • Philadelphia Office: Broad Street Station Bldg.

Official U. S. Marine Corps Photo

Keep Your Plant's Quota "OUT FRONT!"

Victory depends upon materials—as well as men! To keep our American forces "closing in" overseas, you and every other manufacturer here at home must *keep on making* "Out Front" War Bond Quotas!

This means *action now* on *every* point in the fighting 8-Point Plan to step up Payroll Deductions. For instance, have you a 6th War Loan Bond Committee, representing labor, management and other important groups in your company? Selected Team Captains yet—preferably returned veterans? If so, have you instructed them in sales procedure—and given each the Treasury Booklet, *Getting the Order?*

How about War Bond quotas? Each department—and individual—should have one! Assigning responsibilities is vital, too! Have you appointed enough "self-starters" to arrange rallies, competitive progress boards and meeting schedules? Are personal pledge, order or authorization cards printed, and made out in the name of each worker? Planning for resolicitation near the end of the drive? Your State Payroll Chairman is ready now with a detailed Resolicitation Plan. And, have you contracted for space in *all* your regular advertising media to tell the War Bond story?

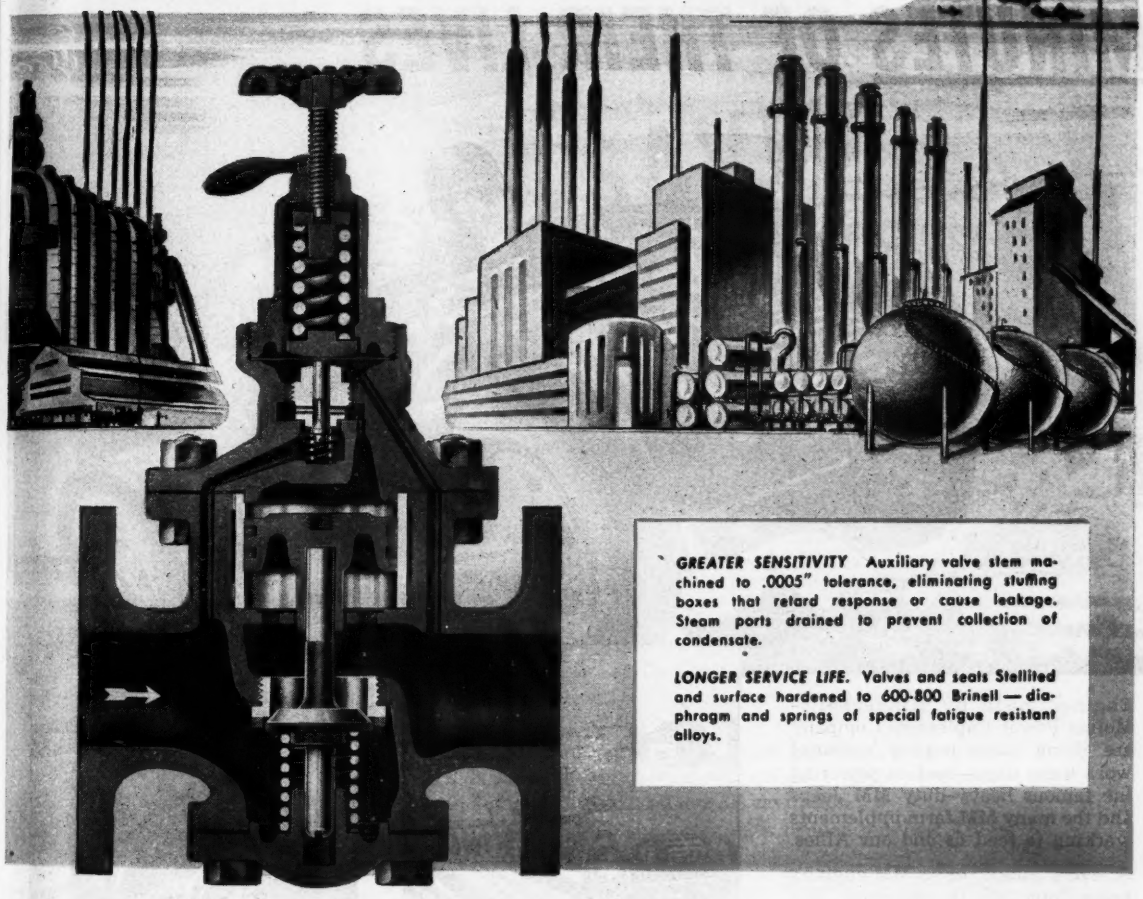
Your positive *Yes* to *all* points in this forward-to-victory 8-Point Plan assures your plant meeting an "Out Front" Quota in the 6th War Loan—and speeds the day of unconditional surrender!

The Treasury Department acknowledges with appreciation the publication of this message by

POWER PLANT ENGINEERING

This is an official U. S. Treasury advertisement—prepared under the auspices of Treasury Department and War Advertising Council.

TODAY, INDUSTRY NEEDS THIS BETTER PRESSURE REDUCING VALVE



GREATER SENSITIVITY Auxiliary valve stem machined to .0005" tolerance, eliminating stuffing boxes that retard response or cause leakage. Steam ports drained to prevent collection of condensate.

LONGER SERVICE LIFE. Valves and seats Stellited and surface hardened to 600-800 Brinell — diaphragm and springs of special fatigue resistant alloys.

ACCURATE & RUGGED—Although there are many pressure reducing valves on the market, certain industries need a valve of extreme accuracy and sensitivity, together with ordinarily unobtainable ruggedness. After-war competition will place more manufacturers in this position. For such customers, Leslie Pressure Reducing Valves are indispensable. A Navy standard for 40 years, these valves find extensive use in the industrial, railroad and maritime fields

SELF-CONTAINED & FULLY AUTOMATIC—Being of the spring-loaded internal pilot, piston-operated type, first developed and further improved by Leslie Co., these valves are unaffected by inlet pressure fluctuations. They do not "hunt" or overcontrol, and thus do not waste steam or endanger processes as "open and shut" or lagging controllers do. They respond smoothly and quickly to load changes from full capacity to "dead-end" shut-off.

Available in bronze body construction and guaranteed for pressures up to 300 p.s.i. and temperatures to 550 degrees F., or in cast steel for pressures up to 600 p.s.i. and temperatures to 750 degrees F.

ESTABLISHED 1900

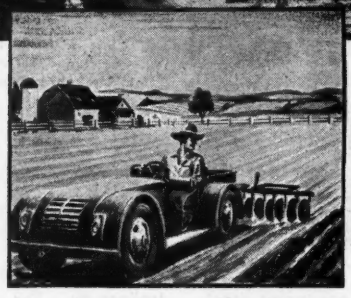
LESLIE

REGULATING VALVES
LESLIE-TYFON WHISTLES

LESLIE CO., LYNDHURST, NEW JERSEY

How a Famous Manufacturer Protects Engines During the

THREE MOST CRITICAL MINUTES OF THEIR LIVES



Engines made by Minneapolis-Moline Power Implement Company are doing some mighty essential work these days—such as powering the famous heavy-duty MM Jeeps and the many MM farm implements working to feed us and our Allies.

So every minute of an MM engine's years-long life is important. But most critical are the first three minutes of the initial run, for 70% of engine wear occurs then.

Now — enter Bowser Exact Liquid Control. Minneapolis-Moline protects its engines during the test run, including those three most dangerous minutes, with a Bowser Oil Circulating System that serves all test blocks.

Periodic losses from scored pistons and bearings have been completely eliminated. There's an important saving in oil, too. Previously, from 7 to 9 quarts were used in testing each engine. Now the oil loss is only about 60 gallons for each 300 engines.

Power plant operators are, of course, well acquainted with Bowser Lubrication Systems, Turbine Oil Conditioners, Force Feed Lubricators, and other liquid control units. Here's an example of Bowser Turbine Oil Conditioner performance: In a leading steel plant, it lowered the acid number of the oil from .0561 to .021 within ten days after installation. What's more, the reconditioned oil showed even less acid than the *new oil* added at the time of installation. Frequent bearing failures were stopped and the average oil temperature was reduced by 51°. Only a little make-up oil is now added periodically—no batches are ever dumped.

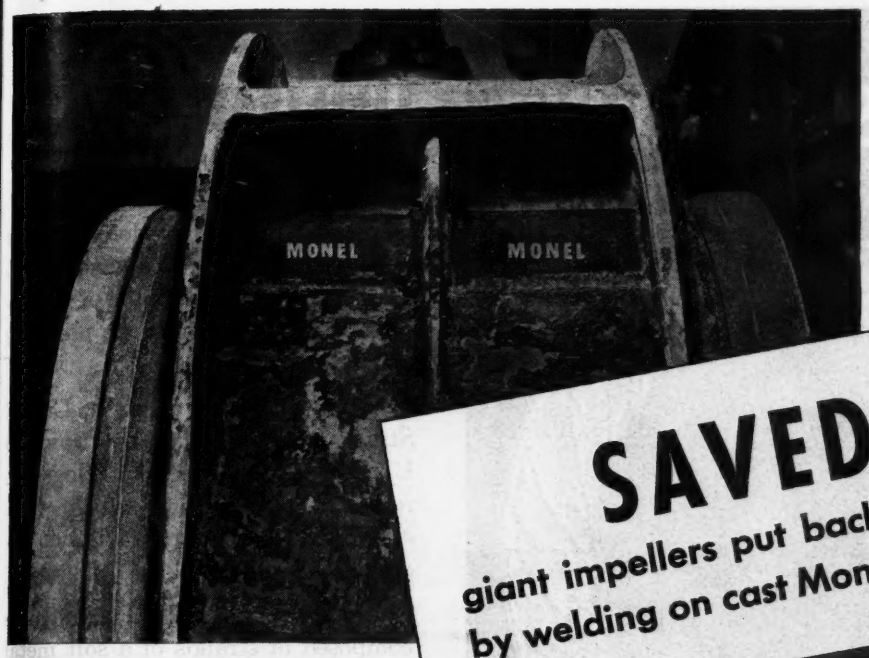
A Bowser engineer will gladly consult with you. Write today. BOWSER, INC., Fort Wayne 2, Indiana.

BUY WAR BONDS

Not only has Bowser's war production earned the Army-Navy E... Bowser equipment has helped earn it for scores of other companies.

BOWSER ESTABLISHED 1885

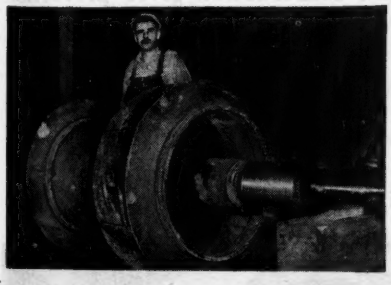
The Name That Means **Exact Control** *of Liquids*



SAVED

giant impellers put back to work by welding on cast Monel patches

CLOSE-UP OF WELDED MONEL "SHOES" on impeller vanes of large salt water pump in the Long Beach plant of Southern California Edison Co., Ltd. While some welds show cavitation after two years' exposure to swiftly moving sea water, the Monel patches remain relatively smooth and fit for long additional service.



TWO 48-INCH IMPELLERS, of manganese bronze, handle 50,000 gallons of sea water per minute in each pump. Welded Monel shoes proved so successful in one pump that similar patches were recently applied to the impeller vanes of a second large pump.

The pump impeller illustrated circulates salt water as a cooling medium.

It's one of four used in two giant pumps in the Long Beach plant of the Southern California Edison Company, Ltd.

The pumps, in service for almost 17 years, are each capable of handling 50,000 gallons of sea water per minute, and operate at 296 r.p.m.

As the 48-inch manganese bronze impellers are exposed to salt water at high speed, the original vanes were damaged long ago by corrosion and cavitation.

At first, repairs were made with bronze patches. These failed in a short time.

Then, over two years ago, new patches of cast Monel were welded in as replacements on one pump's impellers. Less than 100 lbs. of Monel was necessary to repair each 2000 lb. impeller. Since then, the impellers have given no trouble. Although some welds showed the effects of cavitation when examined a few months ago, the patches are relatively smooth and appear ready for many years more service.

Recently, the second pump's impellers were also fitted with welded Monel patches.

Monel not only welds readily,* but both the weld and the repair part *last*. Combining strength, toughness and high corrosion resistance, Monel is uniquely fitted for power applications where *all* of these properties are essential.

**Detailed welding instructions are given in our Technical Bulletin T-2—yours for the asking.*

NICKEL (INCO) ALLOYS

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK 5, N.Y.

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • "Z" NICKEL • NICKEL • Sheet... Strip... Rod... Tubing... Wire... Castings... Welding Rods

UNLIMITED

Stimulated by war-time demands, new industrial processes have emerged requiring equipment capable of operating at higher temperatures, pressures and speeds.

Anticipating such changes, United States Rubber Company provided U. S. Flexible Metallic Packings . . . resilient sealing units which withstand extreme pressures without becoming inert.

These Flexible Metallic Packings are composed of strands of a soft metal alloy, spiralled about a lubricated asbestos central core. Each separate strand contains its own small lubricated core . . . providing maximum resiliency throughout the cross section of the packing.

Such construction gives protection against loss of pressures, assures flow of lubricant under pressure, compensates for play in the shaft.

SERVING THROUGH SCIENCE

EASY TO INSTALL—U. S. Flexible Metallic Packings offer the same convenience of handling in installing as do fibre packings . . . are adaptable to all conventional stuffing boxes . . . require minimum attention on gland regulation adjustment.

NO CRIMPING OF BEARING SURFACE, because spiral construction permits metal being opened up for application, then returns to original shape without distortion of original smooth bearing surface. Style No. 511, shown here has a lead base, and is recommended for temperatures up to 450° F. It may be safely used on centrifugal and reciprocating rods at all speeds. Other styles for temperatures up to 1500° F.

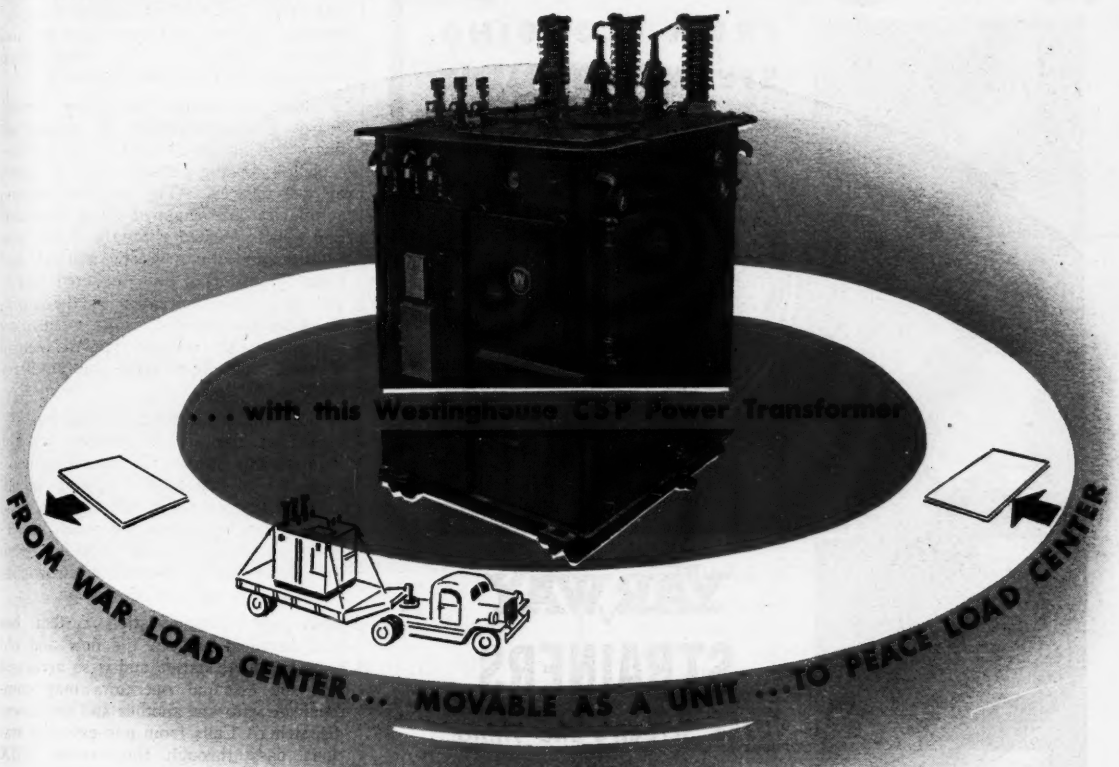
Listen to the Philharmonic-Symphony program over the CBS network Sunday afternoon, 3:00 to 4:30 E.W.T. Carl Van Doren and a guest star present an interlude of historical significance.

UNITED STATES RUBBER COMPANY

1230 SIXTH AVENUE • ROCKEFELLER CENTER • NEW YORK 20, N. Y. • *In Canada:* DOMINION RUBBER CO., LTD.

WHEN PEACE COMES...

RECONVERSION IN HOURS



In a matter of hours, a CSP power transformer can be moved to a new load center. When the day of reconversion comes—just disconnect, roll onto a trailer-truck, take to a new platform, and reconnect.

Westinghouse CSP Power Transformers contain in *ONE UNIT*...

- transformer
- circuit breaker
- voltage regulator
- metering
- protection against —lightning
- protection against —overloads
- protection against —short circuits

Compare this with the time required to move a conventional single-feeder substation . . . with its 43 major components. The Westinghouse CSP power transformer makes reconversion easy and *economical.* It saves man-hours . . . permits practically 100% salvage of the war-load installation.

The Westinghouse CSP power transformer performs *all* the functions of a conventional single-feeder substation. It is completely self-protecting (CSP) against lightning, overload and short-circuit damage. For complete information, call your Westinghouse office or write Westinghouse Electric & Manufacturing Company, Dept. 7-N, East Pittsburgh, Pa. J-70438

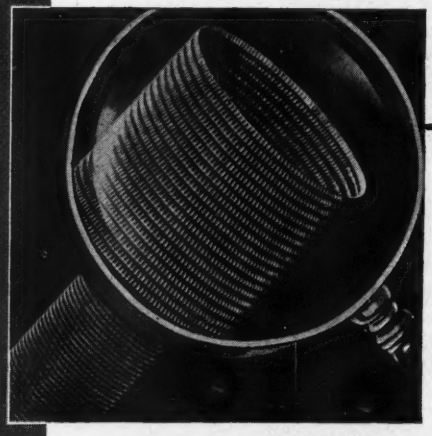
Westinghouse PACKAGED POWER

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

PREVENT

Rust · Scale · Dirt

FROM CLOGGING
STEAM EQUIPMENT



YARWAY

STRAINERS

"The Screen's the Thing"

- *A High Grade Monel Woven Wire Basket* with mesh fine enough to catch the dirt—yet ample free area for passage of clean condensate, oil and other fluids.
- *Body Cadmium Plated Inside and Out for Protection Against Corrosion.*
- *Readily Removed Steel Blow-Off Bushing.*
- *Bushing Automatically Aligns Screen.*
- *Thousands in Use—Sold by Over 100 Mill Supply Houses.*
- *6 Sizes ½" to 2" for Pressures up to 600 Lbs.*

See Your Supply House or write for Bulletin S-200

YARNALL-WARING COMPANY

114 MERMAID AVENUE PHILADELPHIA 18, PA.

YARWAY STRAINERS

Pennsylvania Edison Adds 31,250-Kw Unit at Williamsburg

(*Continued from page 75*)

tion, providing segregation for the steam and feedwater recording instruments, lubricating and seal oil gauges, desuperheating control, hydrogen cooling and electrical controls. This construction was adopted to minimize fire hazard.

Both the turbine and boiler control boards are illuminated by means of fluorescent lamps located in a lighting canopy extending out and above the front of the boards. The smaller station auxiliaries are supplied from distribution panels located throughout the new addition and the magnetic starters and push buttons have been mounted locally and in groups convenient to the auxiliaries being controlled. Both momentary and maintained contact type of control is used, depending upon the auxiliary being controlled.

The station lighting system was designed at the specific request of the Pennsylvania Edison Co. operating engineers to provide ample lighting in all parts of the plant with the view in mind of safety to operating personnel. Emergency lighting has been provided from the station battery, which is thrown on automatically on loss of voltage.

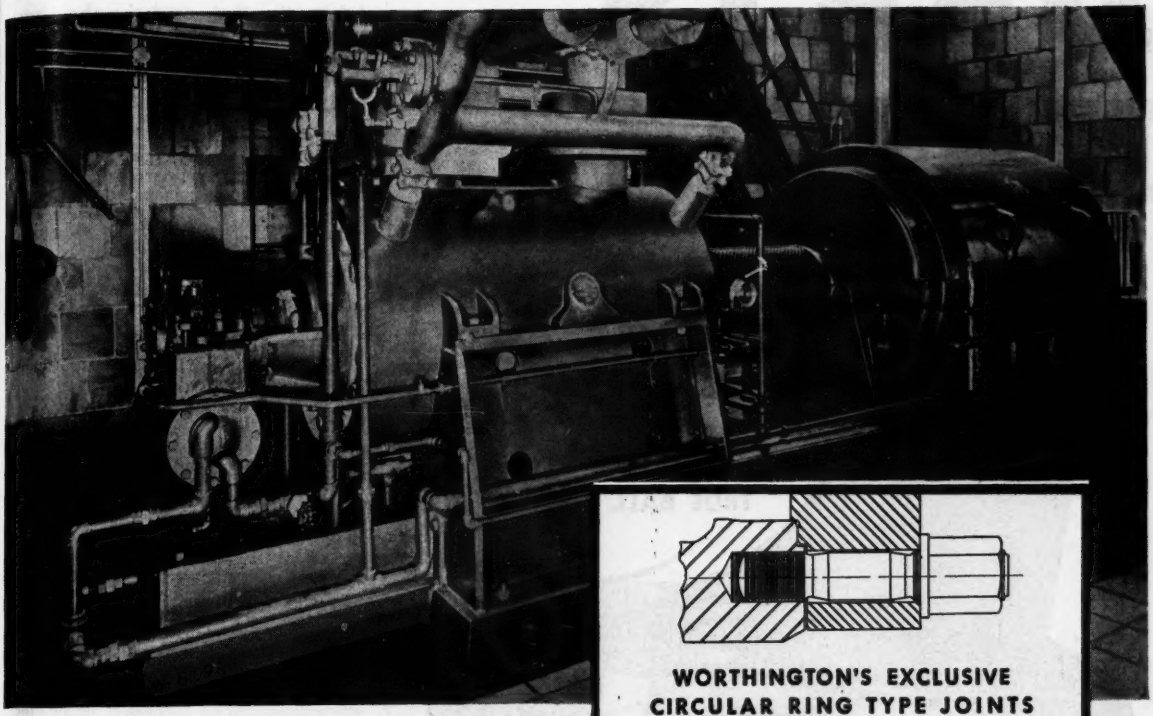
A new communication system has been installed in both the new and old sections of the station and is so arranged that the essential operators may communicate with one another and the power dispatcher. Calls from non-essential stations pass through the station PBX board.

Acknowledgments

For the most complete and cordial co-operation when visiting the Williamsburg Station and compiling data for this article, this writer is deeply indebted to E. H. Werner, president, and W. H. Wade, vice-president, of Pennsylvania Edison Co. and to R. C. Roe, president of Burns and Roe, Inc. and their respective staffs. The fine way in which the men of both organizations had worked closely together in building the new extension was particularly evident to the writer and is also reflected in the details and layout of the station itself.

For Burns and Roe, Inc., Frank L. Jones was construction manager, with Edmund M. Kowkabany as assistant construction manager and Geo. C. Cook in charge of operation. J. A. Frieday of Burns and Roe, Inc. was the general co-ordinator between the job and the New York office of the consultants. For the Pennsylvania Edison Co., J. M. Hughes is superintendent of electric apparatus; Elmer F. Reed, superintendent of production; K. R. Williams, superintendent of Williamsburg Station; and C. W. Smith is efficiency engineer. To every one of these men, as well as to John Buchanan, editor of the Williamsburg Journal, our heartiest thanks.

30,000 HOURS . . . AND MORE!



WORTHINGTON'S EXCLUSIVE CIRCULAR RING TYPE JOINTS

Only Worthington's WC solid case boiler feed pump uses circular ring-type joints throughout, universally accepted as best construction for high pressure equipment. No gaskets needed.

Worthington High Pressure Boiler Feed Pumps make records for continuous operation in many plants

A typical station reports "32,627 continuous hours without major or minor overhaul"—an outstanding record, but not exceptional when you install a Worthington.

In 1923, Worthington supplied the first high pressure (above 1200 p.s.i.) boiler feed pump ever installed in the U. S. Since then, Worthington has consistently led the field in the number of installations in plants using steam at 1200 p.s.i. pressure or above.

Get the Right Pump for the Job

Worthington's WC high pressure boiler feed pump, shown here as installed in a leading power plant, is only one example of the application experience that will help you solve your specific boiler feeding problem.

"Know-How" from Unit Responsibility

It is natural that Worthington, with years of experience in engineering power plant equipment—from prime movers to valves and V-belts—should be able to place *more* "know-how" at your service. Write us. The Worthington Pump and Machinery Corp., Harrison, N. J.

WORTHINGTON *BEHIND THE NAME* WORTHINGTON

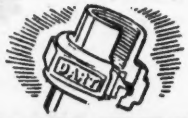
CP4-13

WORLD'S LARGEST MANUFACTURER OF PUMPS

STEAM POWER ROTARY TURBINE WELL CENTRIFUGAL

DARTS HAVE

A lot of unions look alike. Darts look different because they are different—*they have two bronze seats ground to a true ball joint.* That means they *act* differently also. They close perfectly—to *stay* closed; but open readily, if needed, to be used over and over again, and Darts bodies and nuts are made of air-refined malleable iron. That's why economy-wise buyers *insist* on Darts.



DART
UNIONS

Be sure your supplier sends Darts.

E. M. DART MANUFACTURING CO., PROVIDENCE 5, R. I.

NEW EQUIPMENT

Information that you desire about any equipment will be gladly furnished without obligation. WRITE TO POWER PLANT ENGINEERING

Oil Clarifiers

SEVERAL new models of oil clarifiers have recently been announced by Briggs Clarifier Co., 1339 Wisconsin Avenue, N.W., Washington 7, D. C., these are designated as G Series, F Series, DR Series and ZR Series.

Briggs G Series clarifiers are relatively small capacity oil filtration units. They embody the features of refill interchangeability for the three different types of operation—gasoline, natural gas and Diesels using both straight mineral and special additive type oils. G Series clarifiers are designed for service on mobile, marine and light to medium duty stationary engines, and are also suitable for many types of machine tool lubricating systems.

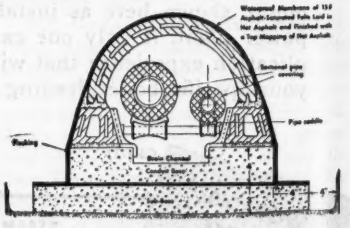
The F Series fuel oil clarifiers are designed for Diesel and gasoline engines consuming from 5 to 10 gph and because of their compact arrangement, they are especially adaptable to mobile Diesels.

Standard DR Series units were designed to meet idustrial needs for oil filters for by-pass installation. Each unit is equipped with a precision built relief valve set to maintain the most efficient operating pressure inside the clarifier and to allow circulation through the clarifier when the oil is cold. Flow capacities range from 1 to 20 gpm, and the maximum working pressure is 100 psi.

ZR Series Clarifiers are designed for the continuous filtration of soluble oils, low viscosity cutting oils and kerosene used in precision grinding, honing, light broaching, milling and lathe work.

Underground Pipe Conduits

H. W. PORTER & Co., 825 Frelinghuysen Ave., Newark, N. J., has recently modified its design of underground pipe conduits for use in exceedingly wet or submerged locations where it has proved entirely successful in keeping out all traces of moisture. The standard Therm-O-Tile design is employed with its internal drain, so that in the event of condensation of moisture out of the air within the conduit, it can and will all be drained out by means of the drain channel shown in the illustration.



In this new design there is a wide sub-base beneath the standard spread-footing foundation. The sub-base is wider for two reasons: (1) to reduce foundation unit pressure, and primarily, (2) to simplify the mechanics of joining the waterproof membranes so that

For a Refractory that Lasts Longer

CRYSTOLON BRICK

by NORTON

Time is the fundamental measure of a practical refractory.

Long life is the practical result of using CRYSTOLON (silicon carbide) brick.

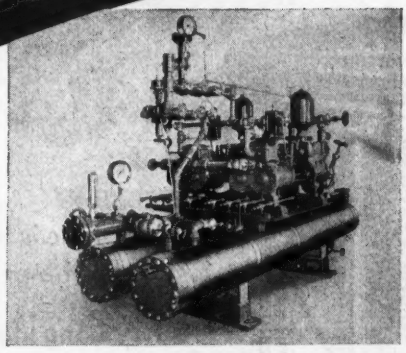
That is the reason for the ever increasing use of CRYSTOLON brick in stoker-fired furnaces, generators of water gas sets, and combustion chambers of high temperature furnaces.

We will gladly provide you with the technical reasons why CRYSTOLON (silicon carbide) brick gives extraordinarily long life under the severest operating conditions.

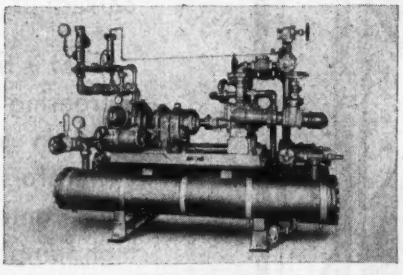
NORTON COMPANY WORCESTER 6, MASSACHUSETTS

Enco Automatic
OIL PUMPING
AND HEATING SYSTEM

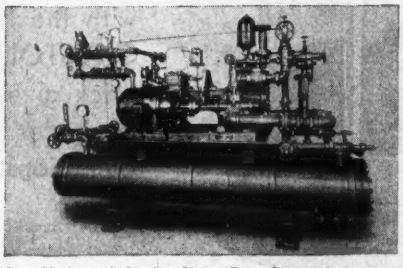
Completly Coordinated



Two Horizontal Duplex Piston Type Steam Pumps and two fuel oil heaters—capacity 15 G. P. H. at 250 lb. pressure with either pump or heater.



One Turbine and One Motor Driven Pump and two fuel oil heaters. Capacity 30 G. P. H. at 150 lb. pressure with either pump or heater.



One Horizontal Duplex Piston Type Steam Pump and one Motor Driven Pump and two fuel oil heaters. Capacity 20 G. P. H. at 300 lb. pressure with either pump or heater.

Every detail part of an Enco Automatic Oil-Heating-and-Pumping Unit System is designed, assembled, checked and tested to make sure that it functions as an element of a completely coordinated unit. The sizes of pipes, fittings, valves and other elements are correctly proportioned for the efficient, dependable operation of the unit as a whole. All hand controls are visible and within reach of the operator for quick starting, stopping or cross-over reconnections between duplicate heaters and pumps. Adjustments and cleaning are similarly simplified.

Single or duplicate heaters and electric or steam-driven pumps are used. Interconnected duplicate units give full capacity with either pump or either heater. Capacities range from 100 to 5000 G. P. H. of heavy bunker oil.

BULLETINS ON REQUEST

OB-37 On oil burning, pumping and heating equipment.

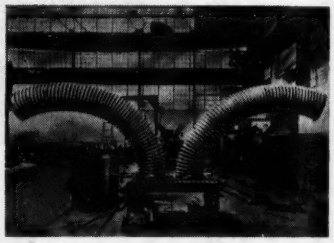
OB-38 Instruction book on care and operation of oil-burner installations.

THE ENGINEER COMPANY
75 WEST STREET Enco NEW YORK 6, N. Y.

leakage will be impossible. The modified design may be described as the standard design hermetically sealed by surrounding the entire conduit with a membrane waterproofing and then placing it on top of the additional subbase. The waterproof membrane usually consists of 15 lb asphalt-saturated felts laid in hot asphalt and finished with a top mopping of hot asphalt.

Corrugated Flexible Connectors

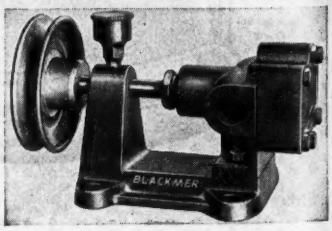
FOR THE FIRST TIME large diameter flexible corrugated stainless steel tubing in long bent lengths, is being manufactured by Zallea Brothers & Johnson, Wilmington 99, Del. In the illustration is shown the application of this tubing as Diesel exhaust connectors bent to 110 deg for an important war use. The tubing shown is 16-in. in diam by 9-ft in length. It is reported that extensive use is being made of this tubing for Diesel engine exhaust and high temperature vapor lines. These connectors have inherent advantages of value to the chemical, power and petroleum industries. The



connectors absorb expansion, contraction and extreme deflection in all planes. They are supplied in sizes 6-in. in diam and larger in carbon steel, any type of stainless steel and other corrosive-resistant alloys, they require no packing and, having no seams are permanently gas-tight. The connectors handle corrosive liquids and gases under pressures up to 30 psi and at temperatures from sub-zero to 1800 F.

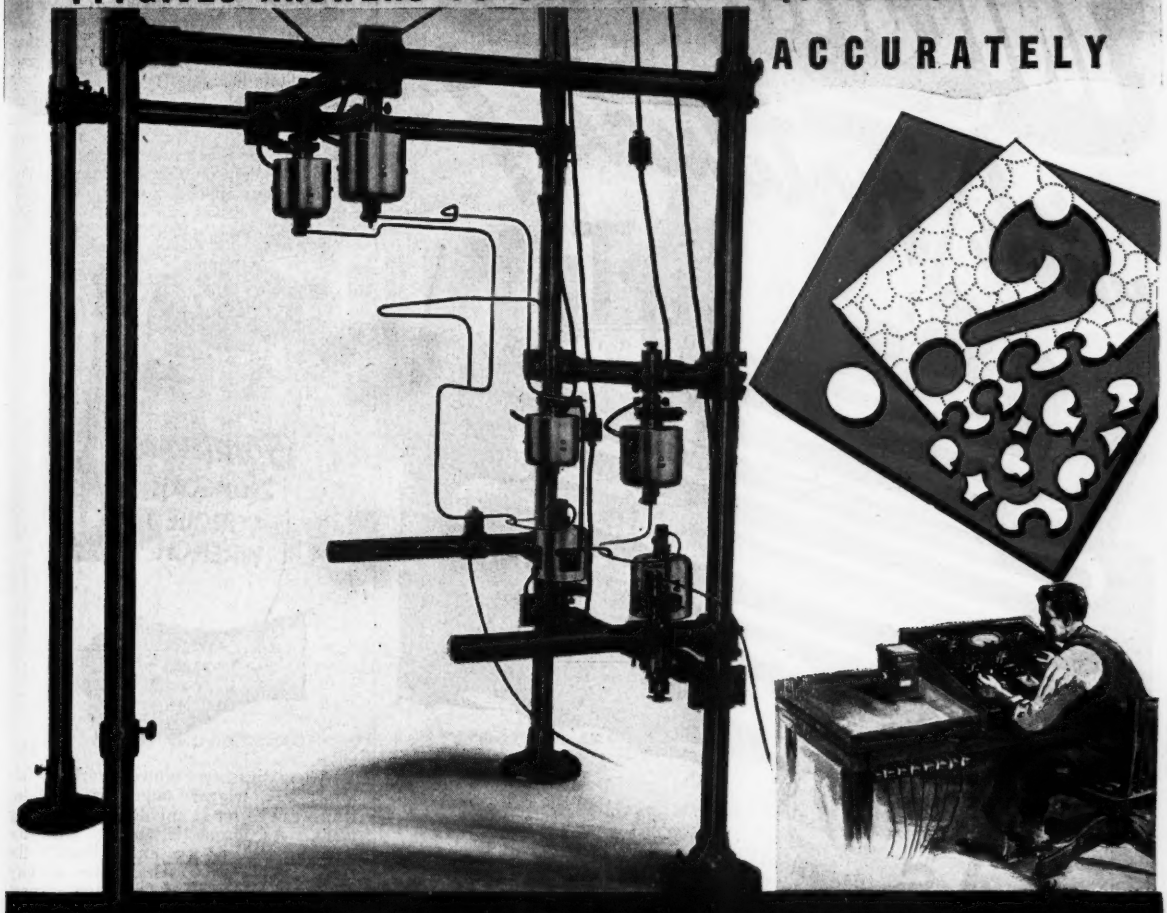
Rotary Pumps

AN ENTIRELY new line of special vane type rotary pumps, with capacities ranging from 2/3 to 10 gpm has recently been announced by the Blackmer Pump Co., Grand Rapids, Mich.



These pumps are of compact design, light in weight, with built-in relief valve optional, furnished with base and flexible coupling for direct connection to prime mover, for "V" or flat belt drive and with special design brackets to meet the mounting specifications of the customer. All iron, bronze fitted, or all bronze units are available. Due to the special bucket design, these pumps are self-adjusting for wear.

DETERMINING MOMENTS AND FORCES ELECTRICALLY ...GIVES ANSWERS TO SCORES OF EQUATIONS ACCURATELY



KELLOGG PIPING ENGINEERS CAN SUPPLY ACCURATE ANSWERS TO AS MANY AS 72 SIMULTANEOUS EQUATIONS—COVERING UP TO 12 POINTS OF FIXATION, WITH THIS APPARATUS!

The super-sensitive instruments which make this possible were designed and are used exclusively in the Kellogg Engineering Department for the sole benefit of Kellogg clients. By their use the most complicated design problems of high pressure, high temperature piping systems are solved accurately and quickly—an exact scientific analysis of the end reactions is arrived at.

There is no guess work, no possibility of error or delay in figuring, when these sensitive Kellogg instruments are used. They reduce figuring time, assure absolutely accurate results and thus save our clients time and money by giving them mechanically and scientifically correct piping systems for their individual needs as well as often substantially reducing the quantity of vital piping material

KELLOGG

THE M. W. KELLOGG COMPANY
Jersey City, N. J. • 225 Broadway, New York 7, N.Y.
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LOS ANGELES: 609 SOUTH GRAND • TULSA: PHILTOWER BLDG.

KELLOGG

M★★★

"Masterflex" Prefabricated Piping Systems • "Masterweld" pressure vessels for Power, Refinery and Chemical Industries. Heat Exchangers. Pyrolytic and Catalytic Cracking Units, Hydroforming, Reforming, Dehydrogenation, Alkylation, Desulphurization. Thermal and Catalytic Polymerization Units • JUIK Processes for Lubricating Oil Plants. Plastic Refractories • Radial Brick Chimneys.

INTESTINES with Fortitude!

PTP

Seamless steel tubes are the intestines of the ship, the power plant, the oil refinery, the locomotive, and the chemical plant...delivering an ever-flowing flood of power to America's mighty production efforts.

Seamless steel tube "know-how" is vitally necessary to keep those lines going steadily. Cold drawn seamless steel PTP tubing achieves accuracy to size and uniformity of gauge through exacting control and thorough inspection at every step in manufacture. Where cost is a factor, and seamless steel tubing required, PTP tubing offers an economical and satisfactory solution to the problem.

★ Official United States Navy photograph. 440 series destroyer; a component part of the great American Fleet, largest in the history of the world.

PIPE & TUBE PRODUCTS
INCORPORATED
Manufacturers of Cold Drawn Seamless Steel Tubing
JERSEY CITY, N. J. • WORKS: READING, PA.

Sensory Torque Wrench

THE P. A. STURTEVANT CO., Addison, Ill., announces the Sturtevant Sensory Torque Wrench —a wrench that in use is faster than thought, still a true permanently accurate Torque Wrench that will stand all ordinary shop abuse and yet remain dead accurate.

The Sensory model closely resembles the previous Sturtevant Torque Wrench in appearance. Here is the difference —whereas the Sturtevant Torque Wrench depended solely on visual reading to determine the applied torque, the new Sturtevant Sensory model embodies two other features—"sound" and "feel."

These Sensory features work as follows: A trigger finger is provided which can be set at any desired signalling point. As torque is applied with the wrench, and at the exact instant the "set" torque is reached, the sensory action (1) sounds a loud and distinct click and (2) imparts a definite strong impulse to the hand. Thus, through three senses, sight, sound and feeling, the operator automatically releases (by reflex action) his pull on the wrench (even before the conscious mind reports it) making torque both fast and dead accurate. Here, through three channels instead of just one, the operator is conscious that the release point is reached, in spite of himself.

G-E Miniature Six-Element Oscillograph

A NEW self-contained, unusually compact, permanent-magnet oscillograph has recently been announced by the General Electric Co. This "baby" oscillograph is known as the Type PM-17-A1. Originally designed for a war application, it has now been adapted for general use.

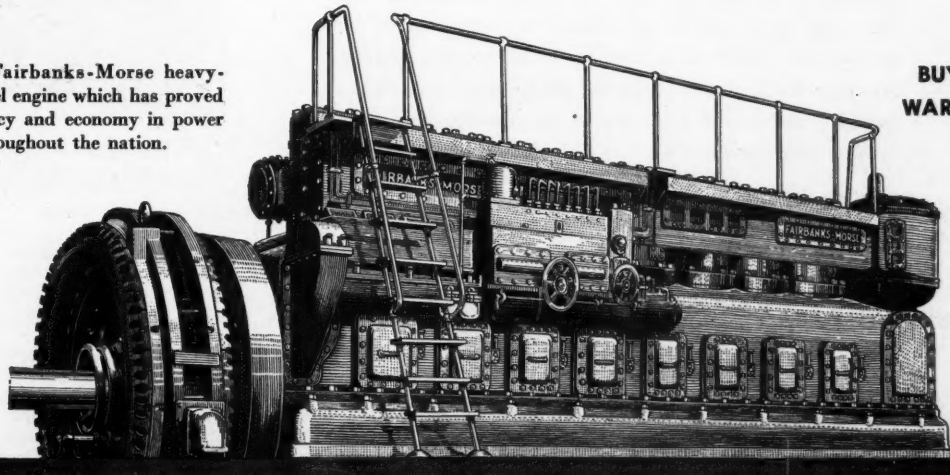
It is the world's smallest six-element unit and consists of three principal systems: first, the optical system; second, the six parallel galvanometer channels; and third, the photosensitive-material transporting mechanism with internal motor and removable film holder, which are all enclosed within a light-tight metal case 4½ by 4½ by 14 in. The weight of the complete instrument is approximately 10 lb.

A name worth remembering!

FAIRBANKS-MORSE

After the war, the name Fairbanks-Morse will continue to mark performance-proved products only, as it has for 114 years. No race to get civilian products onto the market early will tempt us to break this pledge.

Below—Fairbanks-Morse heavy-duty Diesel engine which has proved its efficiency and economy in power plants throughout the nation.

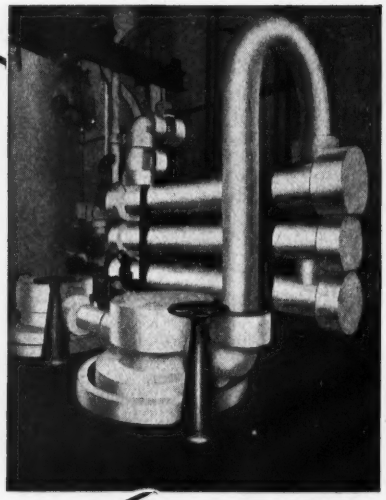


BUY MORE WAR BONDS

DIESEL LOCOMOTIVES • DIESEL ENGINES • GENERATORS • MOTORS • SCALES • PUMPS • STOKERS • RAILROAD AND FARM EQUIPMENT

FAIRBANKS, MORSE & CO., CHICAGO 5, ILLINOIS

The HEART of EFFICIENT BOILER OPERATION



HENSZEY *Continuous Blowdown*

A Henszey system will keep boiler water concentrations within safe margins—preventing foaming, priming, and the formation of sludge and scale (with proper chemical treatment). This absolute control of boiler water concentration is accomplished continuously, automatically and without heat loss.

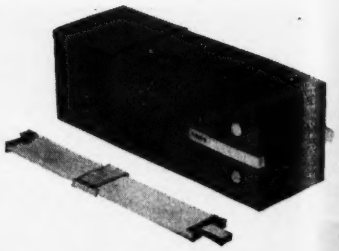
Henszey engineers will gladly make an analysis of your plant, offering practical suggestions to prove what savings can be made by proper boiler water concentration control. Remember that while fuel conservation and boiler efficiency are now patriotic necessities, fuel savings and lower manpower requirements point to lower costs of production—something to think about and plan for in the near future. Contact us now for details.

HENSZEY CO., Dept. C-11, Watertown, Wis.

HENSZEY

CONTINUOUS BLOWDOWN

Flow Indicators • Distillation Systems • Heat Exchangers
Feed Water Meters • Boiler Feed Regulators • Proportioning Valves



Representing a big advance in the oscillograph art, this new instrument makes it possible to obtain performance records on many equipments where the larger general-purpose type cannot be used because of space and weight limitations. It is designed to directly record small values of potential or current, such as the output of amplifying equipment. A wide range of potentials or currents can be recorded by the use of appropriate external resistors, instrument transformers, or shunts.

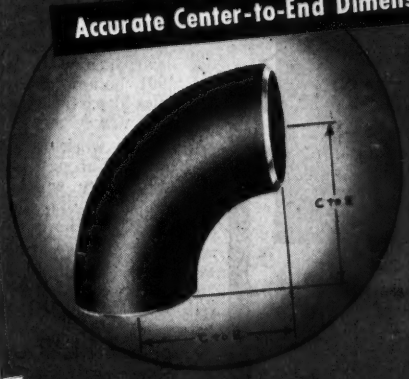
Voltage Regulator

A NEW, improved voltage regulator, the E-M Synchrostat, is announced by the Electric Machinery Mfg Co., Minneapolis. Designed for use with a-c electric generators using direct-connected, belted or motor-driven exciters, 50-60 cycles standard the regulator consists of a basic, metal-enclosed unit adaptable for regular generator switchboard mounting, and for mounting-on-top-of-the-generator in "packaged" power units.

Voltage regulation of the Synchrostat is plus or minus 2 per cent; the regulator quickly responds to load changes to restore generator voltage to normal. The regulator is of the synchronous-contact type; vibrating tungsten contacts of regulator relay operate every half cycle of the a-c wave (120 times a second for 60 cycles) to insert and to remove a resistance in the shunt field circuit of the generator exciter. Regulating action is obtained by the relative time interval the relay contacts are open or closed; the time interval being determined by the voltage from the generator on the regulator relay coil. Regulator operation is unaffected by reasonable external vibration, making it highly suitable for mounting directly on the generator.

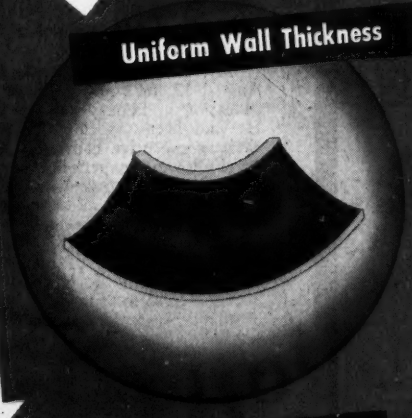
IMPORTANT FEATURES OF MIDWEST WELDING ELBOWS That Save Time and Money

Accurate Center-to-End Dimensions

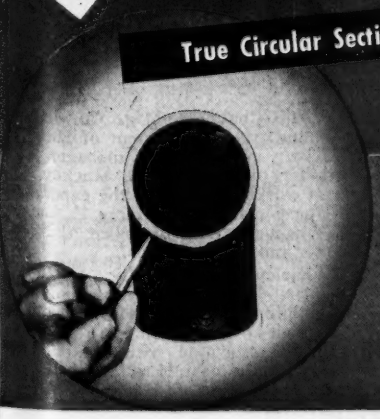


Exact Included Angle

Uniform Wall Thickness



True Circular Section



Midwest Welding Elbows possess the features shown here to an unusual degree because of: (1) a unique manufacturing process whereby the final "size-forging" is in compression in totally enclosing dies that exactly control the metal distribution and (2) special machines for simultaneously machine-beveling both ends and holding the included angle within extremely close limits.

The importance of these features cannot be overemphasized . . . they simplify piping layout . . . they save time in lining up and welding . . . they permit better welds . . . they mean a better piping job.

MIDWEST PIPING & SUPPLY CO., INC.

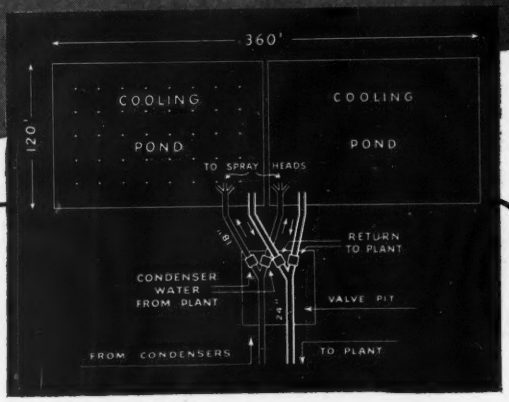
Main Offices 1450 South Second St., St. Louis 4, Mo.

Sales Offices: New York 7—(Eastern Division) 30 Church Street • Chicago 3—645 Marquette Bldg. • Los Angeles 33—520 Anderson Street • Houston 2—229 Shell Bldg. • Tulsa 3—533 Mayo Bldg. South Boston 27—426 First St. • Atlanta 3—Red Rock Bldg. Distributors in Many Cities

MIDWEST WELDING FITTINGS IMPROVE DESIGN AND REDUCE PIPING COSTS

Simplified

CONTROL AND SHUT-OFF OF CONDENSER WATER



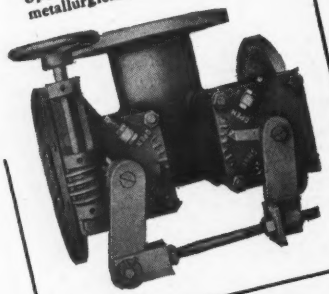
In this installation, four 18-inch motor operated butterfly valves (same as No. 527 illustrated below) are controlled by manual switches from the power plant. This arrangement permits the utilization of one or both cooling ponds or the quick draining of either or both.

For fast, easy control and shut-off of volume and pressure, the R-S Butterfly Valve has no equal. 15 to 900 psi—sub-zero or elevated temperatures.

No. 527. Motor operated 15-pound American Standard. Hand wheel for manual operation in case of current failure. Available in 125-pound iron, 150- and 300-pound steel.

THREE-WAY
R-S BUTTERFLY VALVE No. 611

Unequalled for quick interchange and mixing service. Can be adapted to elevated temperatures and power operation. Precision engineered, metallurgically and mechanically.



If you are interested in fast, effective control and shut-off of air, gas, steam, liquids or semi-solids, state your requirements.

VALVE DIVISION
R-S PRODUCTS CORPORATION
4535 Germantown Ave. • Philadelphia 44, Pa.

R-S Streamlined BUTTERFLY VALVES

The regulator employs a new "swing-door" construction where all operating parts are mounted on the back of the hinged door for ease of inspection, with convenient regulator controls on the door front. Long life of the relay contacts is assured by an automatic contact - polarity - reversing switch; a damping transformer supplies a "biasing" affect across the relay coil, essential in producing stable, accurate voltage regulation.

OBITUARIES

Charles W. Beaver

CHARLES W. BEAVER, associate director of research and product development for the Yale & Towne Mfg. Co., died of heart disease, September 23 at his home in Stamford, Conn. He was born in Cuba, Ill., October 9, 1874. Mr. Beaver was commissioned a lieutenant during the Spanish-American War, later entered newspaper work in New York, and in 1901 became an assistant in the hoist sales department of the Yale & Towne Mfg. Co.

His work for this company brought him a European assignment for several years from which he returned to enter sales activities.

In 1925 he moved to Florida and for two years was president of the Lockwood Mfg. Co. and then retired. Yale & Towne recalled Mr. Beaver in 1934 to organize a research department.

Frank H. Reagan

FRANK H. REAGAN, 72, chairman of the board of the Locke Insulator Corp., died suddenly on September 10 in Baltimore, Md.

Mr. Reagan was born in Corry, Pa., August 13, 1872 and received his formal education in Pennsylvania public schools. He had been associated with Locke in various executive capacities for over 20 yr. Following experience as superintendent of motive power for the Delaware, Lackawanna and Western Railroad in Scranton, Pa., he was made general manager of Locke in 1917. Appointed vice president in charge of manufacturing in 1920, he left the former Victor, N. Y., headquarters to supervise the erection of the present plant in Baltimore. Successive promotions made him president of the corporation in 1926 and chairman of the Board from February, 1939 to the time of his death.

MANUFACTURERS' NEWS

Allis-Chalmers Mfg. Co. has announced the appointment of Hugo W. Liebert, general works manager of the tractor plants, Fred S. Mackey, general works manager of the general machinery plants, and Harry E. Ladwig, works manager of the West Allis foundries and pattern shops.

Kieley & Mueller, Inc., North Bergen, N. J., announces the appointment of Clifford B. Ives as Chief Engineer of their organization. He has been closely associated with control problems for the past 15 yr and will direct the expansion of Kieley & Mueller products in this field.

SAVE COAL...

with FYR-FEEDER Multiple SPREADER Stokers

FYR-FEEDER stoker firing not only saves coal, but also permits you to burn any kind of wet or dry bituminous coal you have available locally — screenings or sweepings, any melting point of ash, free-burning or coking coals.

Burns Coal like Oil: FYR-FEEDER burns fines in suspension, burns larger pieces on grate. Coal is spread over entire fuel bed. Thin fuel bed — no clinkers. Fires can be cleaned in two minutes! Suitable for large or small boilers. Very little maintenance cost. In many cases FYR-FEEDER stokers have made it unnecessary to add another boiler to handle increased loads.

FYR-FEEDER is our own original design. FYR-FEEDER is not a copy of any other stoker but our own invention developed by us, and our engineering experience with spreader stoker design, installation and operation began in the last century.

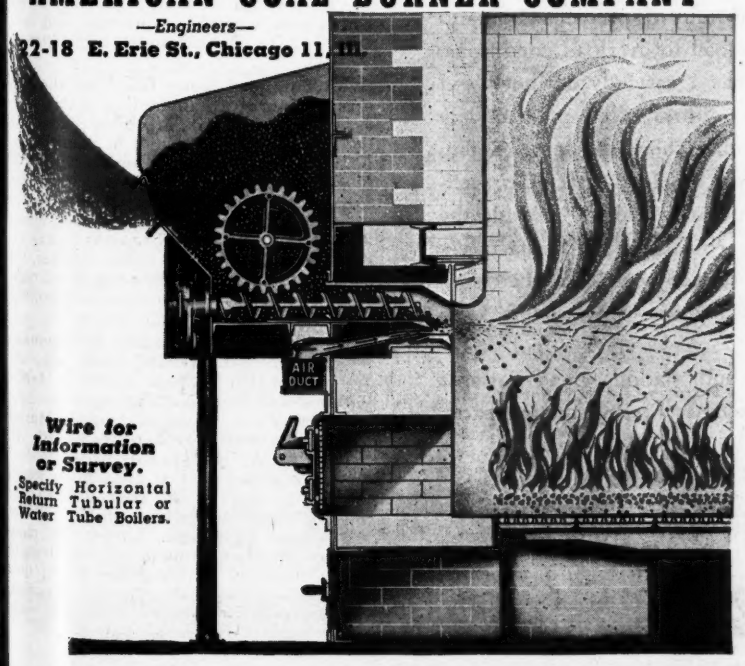
WET COAL IS NO HANDICAP

Coal men like the FYR-FEEDER because FYR-FEEDER users do not insist upon the delivery of "DRY" coal since FYR-FEEDER handles "WET" coal satisfactorily. Regardless of "rain and snow watered" coal, FYR-FEEDER stokers produce plenty of steam from "WET" coal. FYR-FEEDER was designed to use "WET" coal or dry coal.

AMERICAN COAL BURNER COMPANY

—Engineers—

22-18 E. Erie St., Chicago 11, Ill.



Wire for Information or Survey.

Specify Horizontal Return Tubular or Water Tube Boilers.

TREND TO SPREADER STOKERS

There is a definite trend to the use of more and more Spreader Stokers in small, medium and large Industrial Installations.

WHY do so many engineers now consider the Spreader Stoker superior to all other methods of coal firing?

THE FYR-FEEDER MULTIPLE SPREADER STOKER is the World's BEST Spreader Stoker.

The Best Is Vital Now

In ordinary times it is BEST to get the BEST. In times of emergency, when there is an urgent demand for saving coal and man-power, the BEST is a vital necessity.

The FYR-FEEDER Spray-Spred method of firing combines the advantages of the old-style conventional Spreader Stoker and the Pulverized Coal Burner, using only the BEST features of each method plus other FYR-FEEDER advantageous features.

The following questions present themselves:

I. *WHY is the FYR-FEEDER superior to all other types of Spreader Stokers?*

II. *WHY is FYR-FEEDER the World's Simplest Automatic Stoker?*

III. *WHY is FYR-FEEDER the best Industrial Bituminous Coal Burner?*

IV. *WHY and how does FYR-FEEDER save coal and man-power?*

V. *WHY and how does FYR-FEEDER reduce maintenance costs?*

VI. *WHY is FYR-FEEDER the best method of burning WET or dry "coal screenings," bug dust or yard sweepings?*

Fyr-Feeder Stoker Sizes

FYR-FEEDER Multi-Burner Stokers are built in sizes that will burn from 300 to 12000 lbs. of coal per hour. If you expect to be in the market for Automatic Coal Burning Equipment

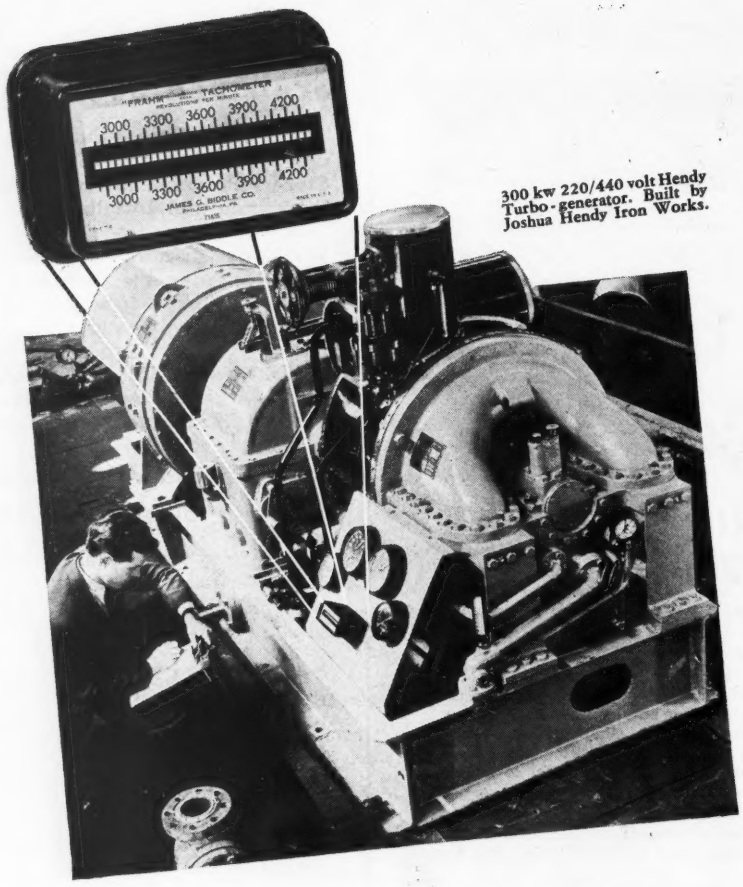
—WIRE

FYR-FEEDER

Spreader Stokers

Chicago 11, Ill.

© by American Coal Burner Co., 1944



300 kw 220/440 volt Hendy Turbo-generator. Built by Joshua Hendy Iron Works.

. . . making **"ASSURANCE DOUBLY SURE"**

***with the* "FRAHM" RESONANT-REED TACHOMETER**

In the modern turbo-generator, uniformity of speed must be maintained over the entire range of no-load to overload conditions.

The Hendy unit shown above has a carefully designed and precisely built governor to assure uniform speed under widely varying load conditions. As a double check, however, Frahm Resonant Reed Tachometers are used on Hendy and other well-known turbo-generators, both large and small, to provide the operator with constant proof of turbine speed. Manufacturers select Frahm instruments for this service because of their simplicity of construction, ease of installation and freedom from maintenance.

Frahm Tachometers are built in both stationary and portable types for use on many kinds of machines having rotating parts. Various ranges are available from 900 to 60,000 r.p.m.

For a complete description of Frahm Tachometers together with list of types and ranges commonly supplied, write for Bulletin 1590-PE.

JAMES G. BIDDLE CO. 1211-13 ARCH ST. PHILADELPHIA 7, PA.

T. Wilson Van Middlesworth has been elected a Director of Public Service Corp. of New Jersey, to fill a vacancy on the Board occasioned by the death of George Barker. Mr. Van Middlesworth has been with Public Service and predecessor companies 42 yr and has been treasurer since 1917. He is a member of the boards of directors of the subsidiary operating companies. He started as a stenographer, became secretary to the treasurer shortly after the formation of the corporation in 1903 and assistant treasurer in 1914. Mr. Van Middlesworth is a native of New Brunswick, was graduated from high school and business college there and lives at 264 Grant Avenue, Highland Park.

Raymond A. White, Jr., newly appointed president of the Beaumont Birch Co., Philadelphia, has announced the election of company officials as a result of the recent death of H. E. Birch, former president. George T. Birch will continue as vice president and treasurer, in addition to acting as Chairman of the Board. Mrs. Florence L. Birch will act as secretary. William G. Davenport has been made vice president in charge of sales.

Directors of Socony-Vacuum Oil Co., Inc., recently elected B. Brewster Jennings as president of the company and chairman of the executive committee to succeed the late John A. Brown. Harold F. Sheets, vice president, was elected chairman of the board of directors, a post which had been vacant since 1935.

Mr. Jennings has been associated with the company and its predecessors for 24 yr, having served most recently as a director and assistant to the president in charge of transportation activities.

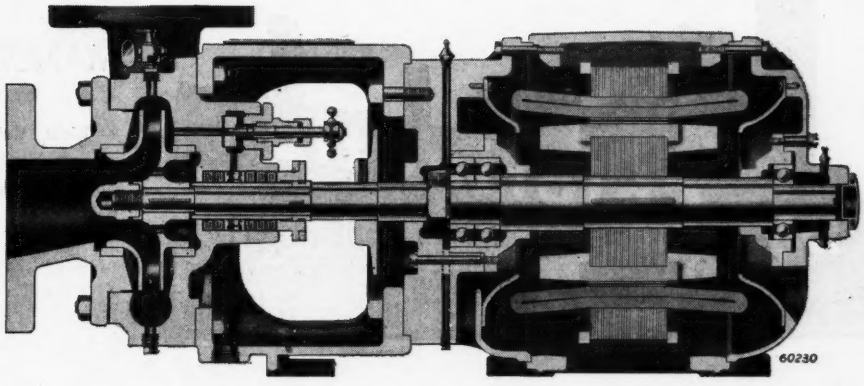
Mr. Sheets has served the company for 37 yr, having started with Vacuum Oil in 1907 and serving until 1924 in its European operations with headquarters at Paris. On his return to America, he was named vice-chairman of Vacuum's lubricating oils committee and became a director in 1930 and vice president in 1931. After the merger he was elected a director and was named to the executive committee in 1933.

The Ford Motor Co. plans the construction of a half million dollar postwar addition at its Memphis plant. The addition of 74,000 sq ft in manufacturing space will permit an average of 30 per cent more production and 20 per cent more employment than in prewar years. Now engaged in machine finishing of more than 35 separate parts for Pratt & Whitney aviation engines, the plant will have to be remodeled completely for civilian automobile production.

The Reliance Electric & Engineering Co. of Cleveland, Ohio, has announced that both the Reliance Marine Plant and Plant No. 2 are to be brought together as a self-contained Marine Division, under Manager Karl H. Meyer. W. H. Haber is to be production manager of this division in which will henceforth be concentrated the long run manufacture of the smaller Reliance equipment. Larger and more specialized equipment will continue to be produced in the main plant, now to be known as the Ivanhoe Division, which will be operated under the management of Robert W. Cornell.

HOW LONG WILL A PUMP LAST?

that depends ....



Cross Section of the Cameron Motorpump

How long a pump will last depends both on what you do with it and how the manufacturer designed and built it. On most jobs the life will be many years. On some services where pumps must handle corrosive liquids, careful selection of materials is necessary to insure uninterrupted service. Correct selection and installation and proper maintenance contribute materially to pump life.

The pump builder's job—what materials he selects, what manufacturing tolerances he maintains, what factors of safety he provides—is very important. Take the Ingersoll-Rand Motorpump as an example. This compact and efficient pump has an extra-heavy shaft and large bearings, and has rigid sections to preserve alignment. These and other details assure that the Motorpump will more than do its share in providing long years of trouble-free operation. Ingersoll-Rand Company, Cameron Pump Division, 11 Broadway, New York 4, N. Y.

The Cameron Motorpump

The Ingersoll-Rand service engineer will be glad to give you further details on the Motorpump. There are also other Ingersoll-Rand pumps for practically any centrifugal pump application.

Ingersoll-Rand

9-402

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • OIL AND GAS ENGINES

MODERN INDUSTRY

prevents slime deposits...

In many of the war's largest industrial developments, including virtually all of the Butadiene, Styrene, and Copolymer Plants of the synthetic rubber program and most of the high octane plants, chlorination has been recognized as the most efficient and economical method of preventing heat exchanger fouling by microbiological accumulations.

These modern plants, which have every facility for determining the best methods to employ, have chosen the Wallace & Tiernan Desliming Process.

At lowest cost, minimum of total solid addition, and without interference with existing corrosion control treatments, chlorination is equally effective in fresh as in salt water; in surface as in well water; in cooling towers as in once-through systems.

The Wallace & Tiernan Desliming Process can be used to equal advantage in your plant, whatever the nature of your slime control problem.

Wallace & Tiernan's thirty years of experience are available to you. CD-8

WALLACE & TIERNAN

PRODUCTS · INC.

Manufacturers of Chlorine and Ammonia Control Apparatus

Belleville 9, New Jersey • Represented in Principal Cities

International General Electric Co. has been awarded contracts to supply a great amount of the needed generating, transmission and distributing equipment for an extensive program of electrification now taking place in Chile to speed industrial expansion there. Three large plants have already been scheduled for production by the Corporacion de Fomento de la Produccion, the Chilean government agency in charge of the development, and more are planned for the near future. A sizeable steel mill will also be built in addition to the power plants. When completed it will be the first such plant to be located in Chile as well as the first on the west coast of South America.

MANUFACTURERS' PERSONALS

Lieut. Col. Charles B. Whitehead, until recently on active duty with the U. S. Army Air Forces, has recently been appointed South American representative of the Sterling Engine Co., Buffalo, N. Y. Col. Whitehead is leaving for Rio de Janeiro, Brazil, and in addition will visit cities in Peru, Chile, Venezuela, Colombia, Ecuador and Bolivia. From an intimate knowledge of South America, where he was engaged in business for a number of years, Col. Whitehead predicts that "vast opportunities await the American company able to offer Latin America economical and dependable power units."

J. H. Jewell has been appointed manager of the Industry Departments of Westinghouse Electric & Mfg. Co. Mr. Jewell has been a member of the Westinghouse organization since joining the company training course in 1920 as a sales student. For 16 yr he was in sales work in the Middle Atlantic District, with headquarters in Philadelphia. In 1940 Mr. Jewell was made manager of the Agency and Specialties Sales Department and in 1943 he became assistant manager of Industry Departments.

C. W. Camp, formerly with Crocker-Wheeler Electric Mfg. Co. for 38 yr, specializing in application engineering, is now associated with Worthington Pump and Machinery Corp. as Consulting Electrical Engineer. Mr. Camp, who replaces the late Harry Wood, will assist in solving electrical application problems for all Worthington sales divisions and district offices. His services will also be utilized by the company's manufacturing departments.

William J. Van Vleck has been appointed manager of the Atlanta Office of Worthington Pump and Machinery Corp., succeeding Edward Stauverman, who, after many years of association with Worthington, has resigned to engage in another line of business. Mr. Van Vleck entered Worthington's employ in 1925 as a member of the student group. Since 1938 he has been assistant manager of the Philadelphia District Office. Prior to that assignment he was application and field service engineer in the same district.

Allison L. Bayles of Larchmont, N. Y. has been elected vice-president of the American Engineering Co., Philadelphia, Pa. Mr. Bayles is a graduate of Lehigh University, has been identified with business and industry in an executive capacity. He comes from the Rogers Diesel and Aircraft Corp.,

ROTA-SIGHT FLOW ALARM

gives positive protection against flow failure!

LIKE A TAUT SENTRY in the dark, this new flow alarm always stays on the alert. "*Advance, Flow, and give the countersign!*" If too low or too high, wham goes the big bell or swiftly a solenoid valve moves to a new position. Your product and your equipment will be surely and safely guarded by the Rota-Sight Flow Rate Alarm.

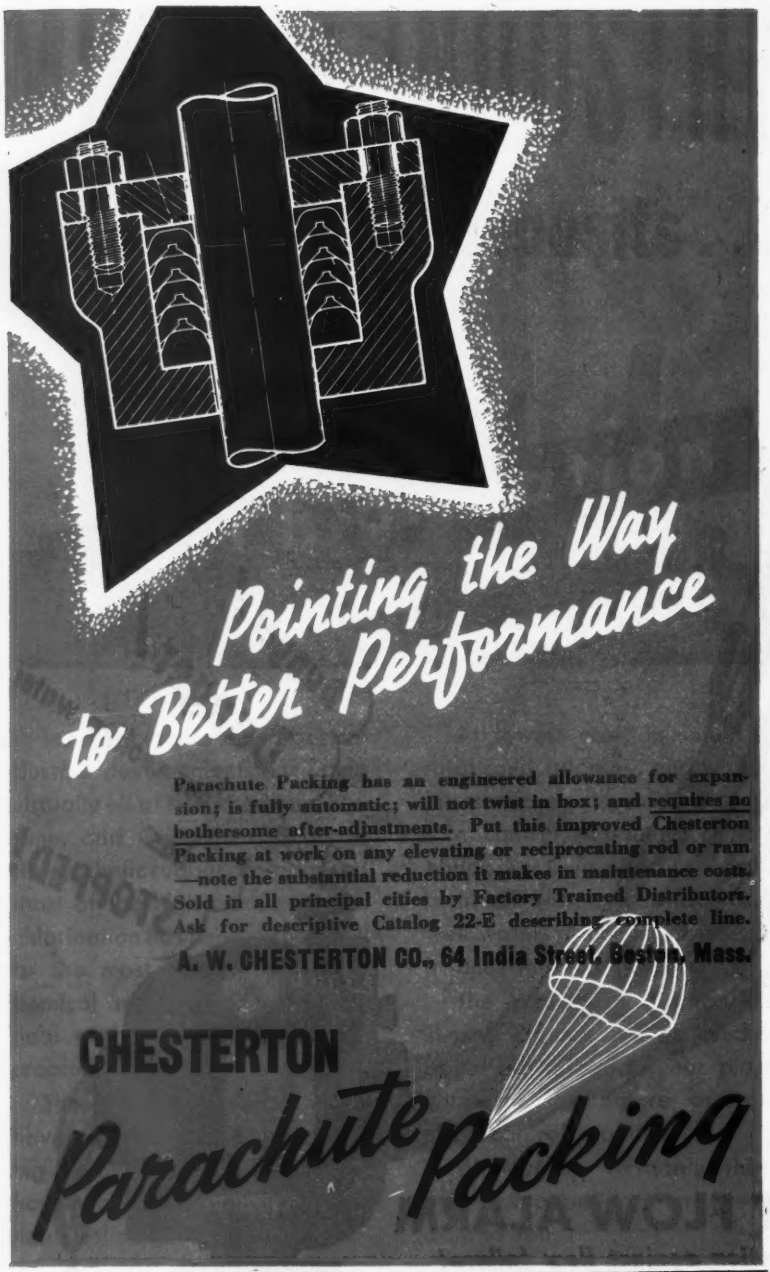
It is made with a transparent, V-ported metering tube, and a metal float which moves up or down *in direct response to flow rate changes only*. The float has a magnetic extension which trips an external switch to operate the alarm circuit. It responds equally well to flows of liquids or gases. Easily made explosion-proof.

The Rota-Sight Alarm is cast in all metals in sizes from ½" to 6". Without the alarm, it is an inexpensive, compact indicator of the true flow rate.

The Rota-Sight and Rota-Sight Alarm have been rapidly adopted by the leaders in the process industries and the equipment manufacturing Companies for measuring coolants, "lube" oils, chemical feeds, etc., to diesel engines, air compressors, turbines, filters, furnaces, stills, heaters, reaction vessels, etc. It has answered their needs for a positive, sure-fire flow rate indicator and alarm.

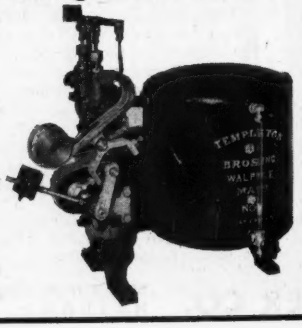
The interesting details are given in Bulletin 92-B—write for it on your Company letterhead.

FISCHER & PORTER CO. 5911 County Line Road HATBORO, PA.


Pointing the Way
to Better Performance
Parachute Packing has an engineered allowance for expansion; is fully automatic; will not twist in box; and requires no bothersome after-adjustments. Put this improved Chesterton Packing at work on any elevating or reciprocating rod or ram —note the substantial reduction it makes in maintenance costs. Sold in all principal cities by Factory Trained Distributors. Ask for descriptive Catalog 22-E describing complete line.
A. W. CHESTERTON CO., 64 India Street, Boston, Mass.
CHESTERTON
Parachute Packing

TEMPLETON RETURN STEAM TRAPS
for Pumping, Boiler Feeding, Draining, Heating and Vacuum Lines

Pumps Water at any temperature or pressure
Open float cannot burst or waterlog
Valves and Seat Bronze or Stainless Steel
Sizes 1 in. to 4 in. inlet and outlet
Capacity 2500 lbs. to 60,000 lbs. water discharge per hr.



Ask for catalogue and prices

TEMPLETON BROS., INC.
699 Main St. Walpole, Mass.

where he occupied the position of Director of Research and Development. Prior to that he was associated with its predecessor company, Hill Diesel Engine Co. of Lansing, Mich. and occupied important posts in the construction, industrial, export and investment fields.

F. C. Harry Vaughan has recently been appointed by the Yarnall-Waring Co. as sales representative in the company's office in Chicago, Ill.

James McClure has been appointed by Allis-Chalmers Mfg. Co. as public relations representative for the Pacific region with headquarters in the Allis-Chalmers San Francisco office. He will be particularly concerned with the company's activities centered in Los Angeles, San Francisco, Portland, Seattle and Salt Lake City.

S. F. Bowser & Co., Inc., has recently appointed Ben H. Swartz as District Sales Manager at San Francisco and Los Angeles, Calif. He is at present discussing West Coast representation with manufacturers.

The International Nickel Co., Inc., has announced that John W. Sands, who has been with the Conservation Division of the War Production Board, Washington, D. C., since 1942, has resumed his duties with the Development and Research Division of the company at New York City.

The appointment of Laurence E. Cooney as vice president and general sales manager of The Austin Co., Cleveland, Ohio, has recently been announced. Mr. Cooney has been associated with The Austin Co. for more than 25 yr.

D. D. Foster Co., Peoples Gas Bldg., Pittsburgh, Pa., has been appointed to represent the Hills-McCanna Co. in that area.

The election of Ellis L. Spray as vice president and general manager of the Westinghouse Electric Elevator Co. has recently been announced. This appointment followed the retirement of Frank C. Reed who had been President of the Elevator Co. since 1936.

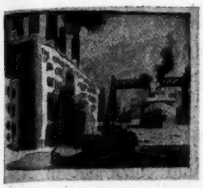
NEWS FROM THE FIELD

National Chemical Exposition in Chicago, November 15-19

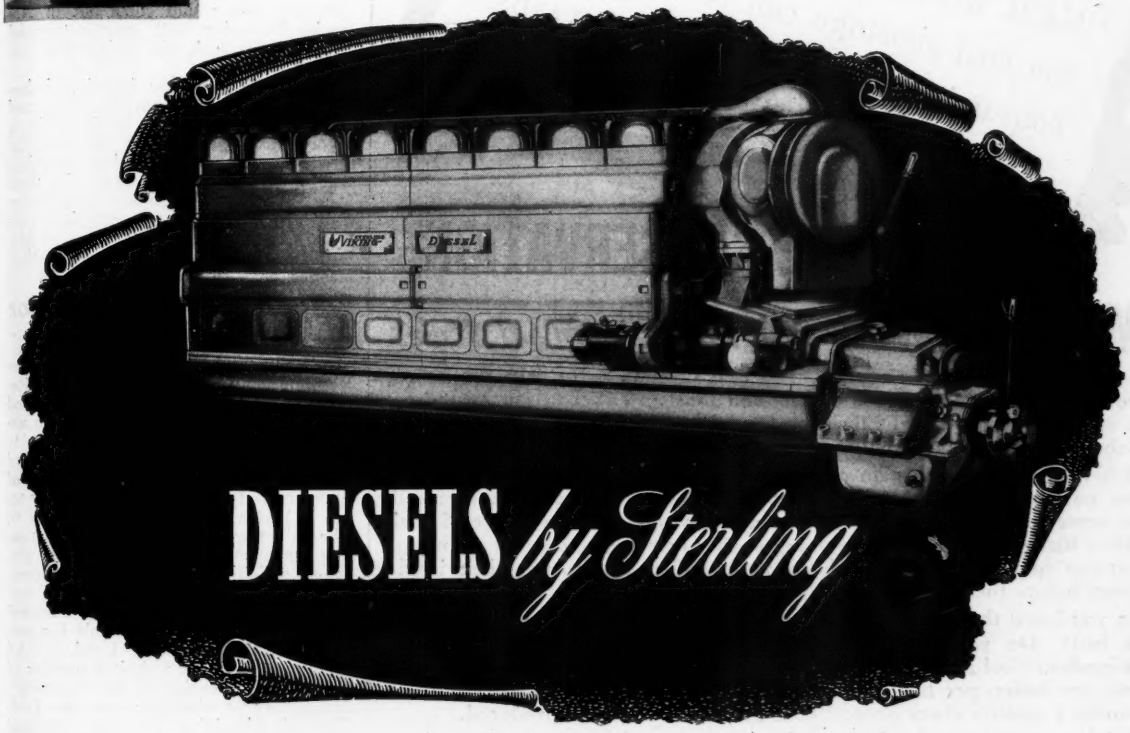
THE NATIONAL CHEMICAL EXPOSITION and the National Industrial Chemical Conference will be held at the Coliseum in Chicago, November 15 to 19. The third biennial presentation sponsored by the Chicago Section of the American Chemical Society will be given added importance because of vital contributions of the industry to the Allied war effort and its vast significant postwar civilian potentialities.

The Tool Engineer—Official Magazine of ASTE

THE TOOL ENGINEER, the official magazine of the American Society of Tool Engineers, will be published by the Society commencing with the February, 1945, issue, according to the announcement made by Adrian L. Potter, Executive Secretary. For the past ten years, The Tool Engineer has been published by an independent contractor.



ENGINEERED FOR THE FUTURE ...AVAILABLE NOW



FIFTEEN years have been spent in designing, building and testing the new Sterling Viking diesel. Now the engine of the future is ready for you today.

Into this masterpiece of engineering design and craftsmanship has been built the most advanced thinking of our times to give you an engine as compact and efficient as a gasoline engine of the same power rating—plus the economy of diesel fuel.

It bears a name which for forty years has been the mark of dependability.

If you are planning a change in your war-tired power plant—write for complete specifications of the Sterling Viking diesel—newest in the line of Sterling engines—diesel, gasoline or gas ranging in power from 85 hp. to 1200 hp.

"KEEP BUYING WAR BONDS"

ARMY E NAVY

STERLING VIKING DIESEL

STERLING ENGINE COMPANY 1272 Niagara St., Buffalo 13, N. Y.

New York City, 900 Chrysler Bldg. • Washington, D. C., 806 Evans Bldg. • Chicago, Illinois, 855 Board of Trade Bldg.

"Next winter's estimated 20-million ton coal shortage can be cancelled by consuming 5% less."—GEORGE EDWARDS, *Advisory Editor POWER, May 1944.*

MORE CONSERVATION—
MORE POWER *with Richardson Coal Scales*

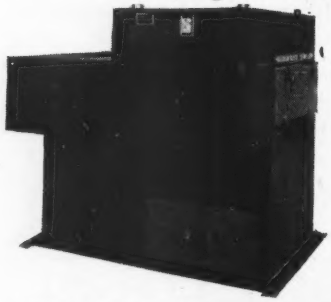
To stretch America's seriously limited coal supply . . . to help our nation meet the estimated needs of 620 million tons . . . Richardson urges you to aid the National Fuel Efficiency Council attain its first year's objective —the conservation of 29 million tons of coal.

Richardson can help you do your part by getting the most out of the coal you now have—or the little that you may get, should the shortage call for some form of allocation this winter. By weighing every ounce of coal with a Richardson Scale and knowing exactly how much coal you are using, you can spot waste, identify the wasteful boilers and correct their inefficiency before fuel losses become serious.

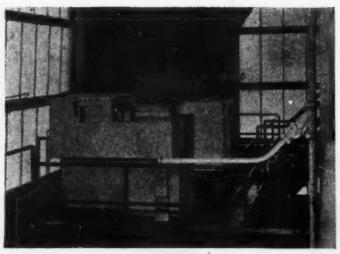
Do you know the evaporation of each of your boilers? Is each one doing its best? Do you know exactly the total evaporation of your plant? Richardson Coal Scales give you continuously accurate and dependable records per boiler, per hour, per shift, per day or month or year . . . They provide a positive check on coal used in relation to power produced.

Weigh your coal from bunker to stoker hopper or pulverizer with Richardson Automatic Coal Scales—used by hundreds of industrials, public utilities and municipalities.

Bulletin 1143 gives technical data, photographs and diagrams of standard and elongated models. Write today for your copy.



Typical Richardson Streamlined Dustproof Automatic Apron Feed Conveyor Type Coal Scale.



Two of Eight Richardson Coal Scales Weighing from Hoppers to Pulverisers in a Large Public Utility Power Plant.

Cooperate with the NATIONAL FUEL EFFICIENCY COUNCIL in its Coal-Saving Goal of 29 Million Tons!

6073

RICHARDSON SCALE CO.
CLIFTON, N. J.

Atlanta • Boston • Chicago • Omaha • Montreal • New York • Philadelphia Minneapolis • Detroit • San Francisco • Toronto • Wichita • Pittsburgh

ASTM Publishes New Book of Standards

HEAVY DEMANDS FOR the 1942 Book of ASTM Standards and its Supplements occasioned by the war production efforts have necessitated advancing by a full year publication of the next book. Normally this would come out in November-December 1945 on the triennial basis, but the book will be issued in December 1944.

Very widely used by American industry and many branches of state and federal governments, this book providing authoritative specifications and tests for a wide range of engineering materials, will cover some 6000 pages in three parts: I, Metals; II, Nonmetallic Materials—Constructional (cement, lime, concrete, paint, etc.); III, Nonmetallic Materials — General (petroleum, textiles, plastics, coal, rubber, etc.).

Proposed Recommendation for Valves Approved

THE PROPOSED Simplified Practice Recommendation for Iron and Steel Relief Valves for Petroleum, Chemical and General Industrial Services, has been approved for promulgation, according to an announcement by the Division of Simplified Practice, National Bureau of Standards. It became effective on October 1, 1944 and is identified as R205-44. The valves covered by this recommendation are primarily intended for air, gas, vapor and liquid service requirements for oil refineries, gasoline plants, synthetic rubber projects, and chemical plants. Some types are suitable for general industrial service. Until printed copies are available, a limited number of mimeographed copies of the recommendation may be obtained from the Division of Simplified Practice, National Bureau of Standards, Washington 25, D. C.

Basil Manly Elected Chairman of Federal Power Commission

AT ITS FIRST meeting with full membership since the Senate's confirmation of the appointment of Commissioner Leland Olds, the Federal Power Commission on September 21, elected Basil Manly its Chairman for the period ending June 22, 1948, the expiration date of Mr. Manly's present appointment. Mr. Olds, the Commission's former Chairman, was elected Vice Chairman for the remainder of 1944.

WPB Reports Increase in Electric Lamp Production

THE WAR PRODUCTION BOARD has recently reported that the production of electric lamps and bulbs for illumination purposes in the second quarter of 1944 totaled $38,572,000, an increase of 3.8 per cent over $37,268,000 volume in the preceding quarter and 21.1 per cent over the $31,846,000 total for the second quarter of 1943.

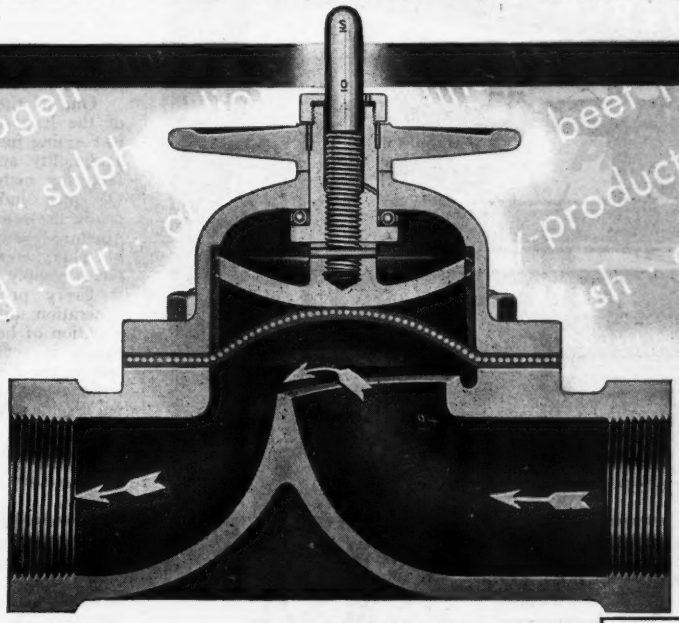
National Power Show

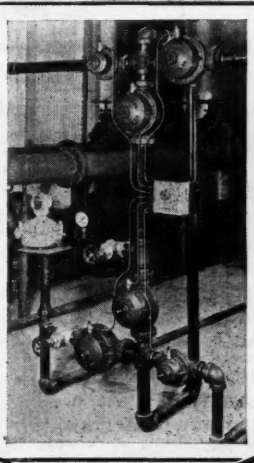
THE 16TH National Exposition of Power and Mechanical Engineering, which is to be held in Madison Square Garden, New York, November 27 to December 2, was originally planned to serve in great part as an aid to war production. Recently the definitely favorable aspect of the war against Ger-

ANNOUNCING

The most practical valve for hard to handle liquids

1455 Diaphragm Valve, Screwed or Flanged. Pressures to 150 lbs., Temperatures to 150° F. Sizes from ½" to 6". Semi-steel body and bonnet, Stainless Steel stem. Non-ferrous bodies by special order. Linings—rubber, glass or lead.





Replaces more expensive valves in many services at substantial savings in initial cost and maintenance

McALEAR NO. 1455 DIAPHRAGM VALVE—extensively used in chemical plants, mines, sewage disposal plants, water works, paint factories, paper mills, food processing and other industries—has proved practically indestructible in service with upwards of 100 different types of acids, alkalies, abrasives and suspended solids.

Can Not Leak

This valve requires *no reseating*—and *no leakage is possible*—because it does not depend on metal-to-metal contact for closure. Positive shut-off is provided by diaphragm *—even when solids are trapped on seat.* Shape of weir prevents accumulation of solids—, offers minimum resistance to flow. Mechanism is trouble-free—*can not freeze* in outdoor service—requires *no repacking—no stuffing box,* because diaphragm completely separates fluids from working parts. Thus maintenance is minimized. The long-life diaphragm can easily be replaced without removing valve from line.

Installable in Any Position

Valve may be installed in horizontal or vertical position, below or above ground, with the hand wheel in any position, without danger of leaks. It is suited for on-or-off service where a tight shut-off is desired, or for throttling service within certain limitations. Special types, singly or in batteries, may be operated from remote points by air or water pressure controlled by automatic time clock, or pilot.

Photo shows pilot-operated No. 1455 Diaphragm Valves controlling flow rate during backwash and rinse cycles. For specifications, dimensional drawings, adaptations for pilot operation or remote control, and on linings suited for specific services, write for *McAlear Diaphragm Valve Bulletin,* McAlear Manufacturing Company, 1915 S. Western Ave., Chicago 8. *Affiliated with Hanlon-Waters Co., Tulsa; Climax Engineering Company, Clinton, Iowa.*

H-W McALEAR controls

PRESSURE · FLOW · LIQUID LEVEL · TEMPERATURE

for STEAM, WATER, AIR, OIL-GAS

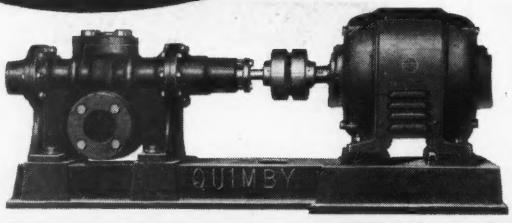
WELDED TANKS
BOLTED TANKS
SEPARATORS

SCREW · ROTEX · CENTRIFUGAL · CHEMICAL

QUIMBY PUMPS

Quimby Pumps have a way of keeping everlastingly at it, without any sign of wear or letdown in efficiency, far beyond the usual life-expectancy of a pump.

KEEP EVERLASTINGLY AT IT



QUIMBY PUMP COMPANY
INCORPORATED
Division of H. K. Porter Company, Inc.
PITTSBURGH, PENNSYLVANIA
FACTORIES:
Pittsburgh, Pa. • Blairsville, Pa. • Newark, N. J. • New Brunswick, N. J.

COMBINATION
NON-TILT, NON-SLIP VALVES
Protect Pumps against wasteful "over-speeding"

The tilting action of some reciprocating pump valves causes the seat to wear unevenly—which means the pump has to work faster and faster to carry its load.

COMBINATION Pump Valves enable you to get theoretical capacity out of your pumps without racing and wasting valuable steam. They prevent tilting and consequent pump slippage because they lift straight. They save on repair bills, too, because their seat, stud and springs are made of long-wearing Phosphor Bronze.

These improved pump valves match the fine performance of COMBINATION Silent Check Valves. Ask for descriptive folder with dimensions, prices and further information.

For Boiler Feed
Vacuum, Condenser
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many and the political pressures for a shaping of reconversion plans before the national election, have sharply altered the industrial outlook. It now appears that the Exposition will cater more strongly to the needs of civilian production than had been expected. Exhibitors are in some instances altering their plans accordingly.

Because of preparations to continue the state of war indefinitely, regardless of Germany's expected capitulation, on the other hand, many exhibits will contain samples of war products as well as mechanical equipment, materials and supplies pertaining thereto. Moreover the logistics of the armies of occupation, plus demobilization of the fighting forces will perpetuate a sharp division in many branches of industry between government and private work for many months to come.

One of the most important purposes of the Exposition will be its assistance in forming judgments as to the probable availability and uses of various manufacturing materials in months to come. On such judgments very largely depends the selection of designs for manufactured products and all the problems of plant equipment, arrangement and power supply which follow thereon.

Every problem connected with the generation, distribution, control and application of heat and power in manufacturing is reflected in more ways than one by the Power Show displays. A preliminary review of products that will be on display indicates that the following classifications will be well represented: heat and power production, distribution of energy, control appliances, auxiliary apparatus, instruments for indicating and recording measurements of quantities and pressures, power transmissions, material handling equipment, engineering materials, engineering specialties, machines and tools. In all categories are included products designed for the construction, operation and maintenance of manufacturing establishments.

Like its predecessors, the Power Show will be closed to the public and open only by invitation and registration to persons associated directly with activities in the power field. The show is under the management of the International Exposition Co., of which Charles F. Roth, manager of the show, is president.

Plant Improvements Permitted by WPB

ELECTRIC POWER, water, natural and manufactured gas and central steam heating public utilities have been granted the right to make certain minor plant additions and extensions up to $10,000 in material cost, without obtaining approval from the Office of War Utilities of the War Production Board, according to a recent OWU announcement. The limit formerly was $1500.

At the same time, OWU has revoked the requirements that purchase of certain critical items (formerly listed in Utilities Order U-1) be approved by Regional Utility Engineers. Furthermore, limitations on purchases of specific items of materials that were contained in Schedule B of Order U-1, also have been removed. As a result of these actions, utilities may purchase materials if their inventories on hand do not exceed their minimum requirements or more than a 90-day supply of such materials.

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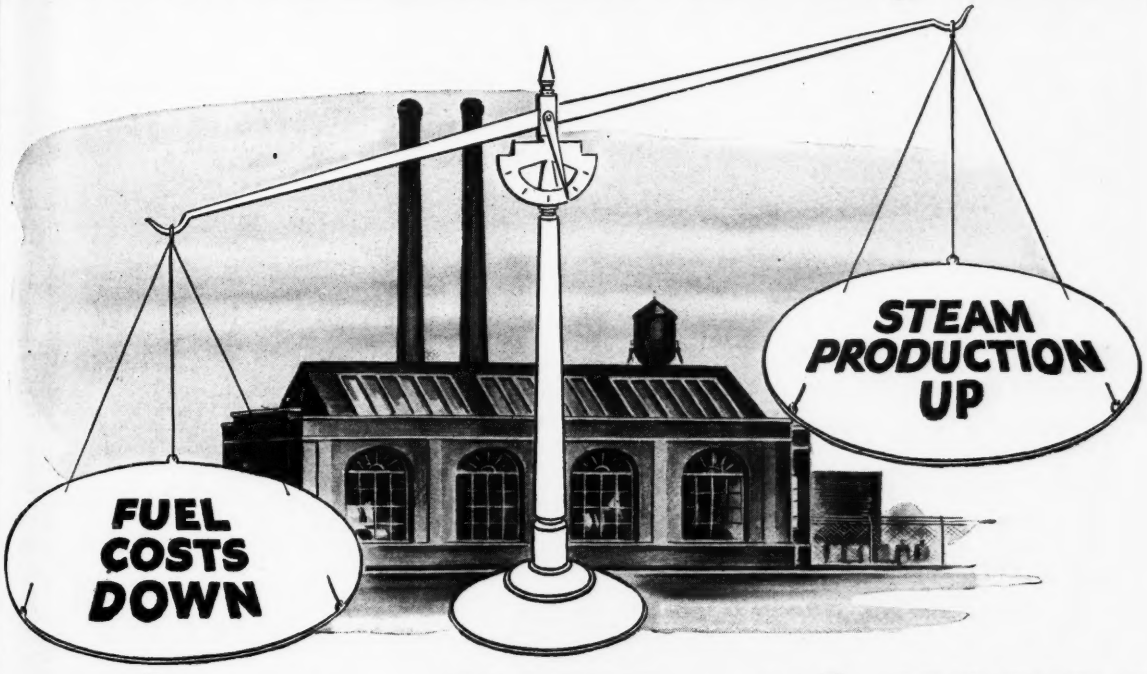

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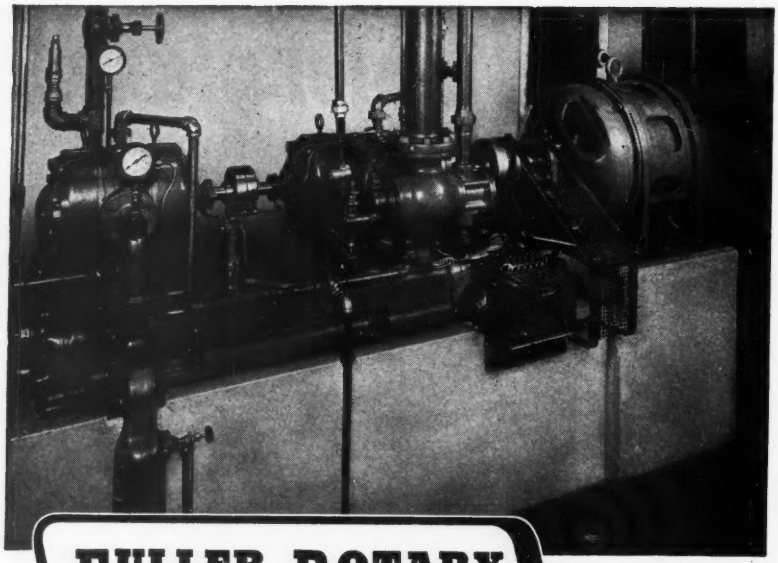

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NEW ENGINEERING BOOKS

The Oxy-Acetylene Handbook. 587 pages, 6½ by 9¼ in., cloth, illustrated. Published by The Linde Air Products Co., 30 East 42nd St., New York 17, N. Y., 1943. Price $1.50.

The Oxy-Acetylene Handbook has been planned to be a basic handbook or manual on oxy-acetylene welding and cutting and their related processes. It has been planned specifically to be of use in colleges, vocational schools, and secondary schools, and in other teaching institutions having courses in welding, construction methods, shop and other vocational and technical subjects.

The book should also be of interest, however, to those in industrial plants who are responsible for the training of welding and cutting operators. It will be of use to plant management people, engineers, designers, superintendents, foremen, and operators in shops where the oxy-acetylene processes are or might be used as production or maintenance tools.

It covers the entire range of the oxy-acetylene process, giving clear, easy-to-follow instructions for handling all the common commercial metals, together with simple explanations of the fundamental principles of the various methods of depositing and controlling molten metal.

This new handbook supersedes and replaces "The Oxwelder's Manual"—which in more recent years has appeared as "The Oxwelder's Handbook."

Control of Electric Motors. By Paisley B. Harwood. Second edition, 479 pages, 6 by 8½ in., cloth, illustrated. Published by John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1944. Price $5.00.

The object of this book is to describe briefly the characteristics of various types of motors and to explain how these characteristics are used for control purposes. The design, construction and operating characteristics of a number of controllers and control devices are discussed, and methods of combining these devices to secure a desired result are described. Problems frequently encountered, such as motor acceleration, dynamic braking, and resistor design, are discussed in detail. In short, this one volume provides a general source of information for everyone working with electrical motors whether the interest is in design, installation, or operation.

The book was first published in 1936. As pointed out by the author in the preface to this second edition, users of the book were interested enough to offer many suggestions and comments to the author, all of which were given consideration in the preparation of the second edition. Most frequent requests were for more information about synchronous motor control and about variable-voltage control. As a consequence, a complete chapter on each of these subjects has been added. Many new tables giving the ratings of motors and controllers have been included.

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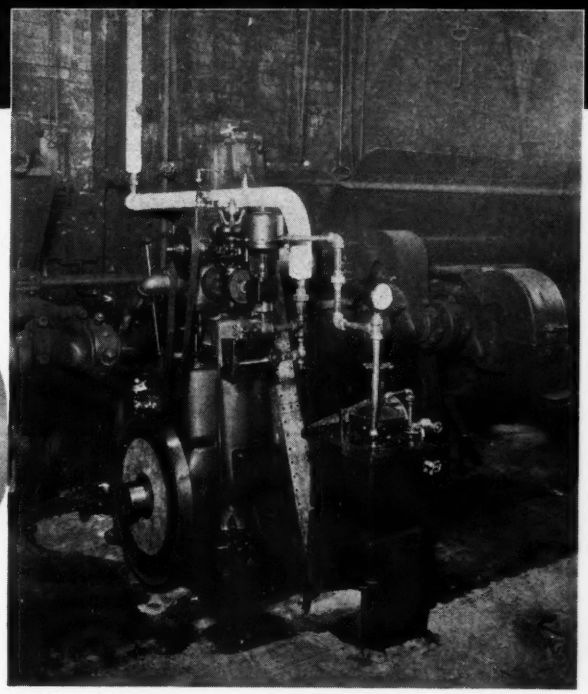

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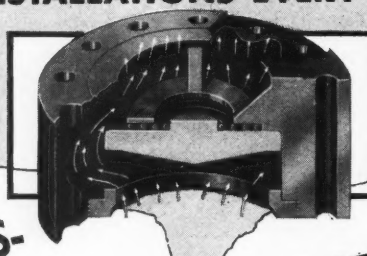

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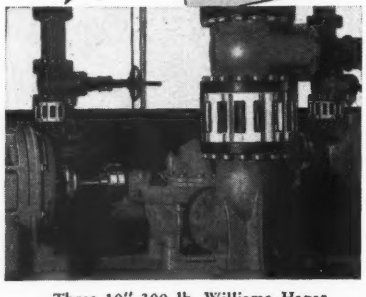

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Throughout, both the text and the illustrations have been revised to conform to the latest practice and to include recently developed devices and methods. The arrangement of the book has been radically changed from the first edition; controllers now being described in the chapters covering the types of motors to which they apply.

Fuel Conservation Manual. Prepared by The Fuel Conservation Council for War, 500 West Oklahoma Avenue, Milwaukee 7, Wis.

Just off the press is a free fuel conservation manual, prepared by the Fuel Conservation Council for War. This book is the result of cooperative effort of the manufacturers of automatic controls, who are members of the Council. It indicates the purpose and application of the various types of controls in relation to the big national fuel conservation job just ahead. Entirely non-promotional in nature, the manual treats its subject from the educational and practical approach, is a valuable book for anyone connected with the heating or maintenance of any building other than family homes.

The book is available upon request from the Fuel Conservation Council for War, 500 W. Oklahoma Avenue, Milwaukee 7, Wis.

Alternating-Current Circuits. By Russell M. Kerchner and George F. Corcoran. Second edition, 553 pages, 5½ by 8⅜ in., 489 illustrations, cloth. Published by John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1943. Price $4.75

This is a new edition of a book that is already well-established as one of the finest in its field It is a book written primarily as a textbook for courses in alternating-current circuits as offered to junior electrical engineering students by most engineering colleges. In addition to the fundamentals of alternating-current circuits, the book includes such specialized topics as energy measurements in polyphase circuits, electric filter theory, symmetrical components, and short-circuit calculations.

The method of presentation used is an outgrowth of the teaching experience which the authors have had at several institutions, and a distinct effort has been made to produce a teachable book.

Problems for which answers are given have been included in many places in the text material immediately following the presentation of certain principles. These problems are primarily intended as exercises which will help the student determine for himself whether he has a workable knowledge of the principles involved. The sequence of the problems at the end of the chapters corresponds to the order in which the text material is presented.

The second edition contains a number of changes from the first edition, made primarily to assist the student in grasping more readily the principles of circuit analysis. For instance, less stress has been placed upon the detailed method of combining instantaneous currents and voltages algebraically so as to bring the student into the study of some of the more interesting principles of circuit analysis as rapidly as possible.

Mr. Kerchner is Professor of Electrical Engineering at the Kansas State College, and Mr. Corcoran is Professor and Chairman of the Electrical Engineering Department at the University of Maryland.

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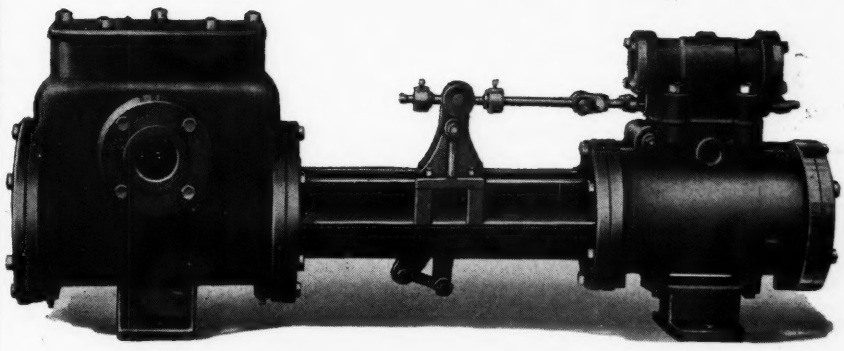

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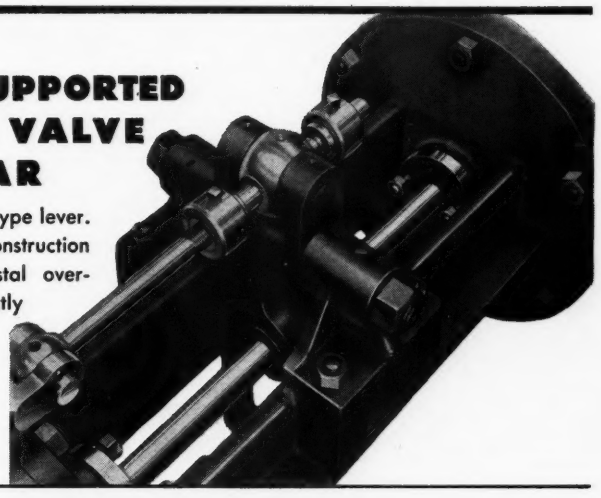

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Basic Mathematics. By Paul G. Andres, Hugh J. Miser, and Haim Reingold First edition, 726 pages, 6 by 8½ in., cloth, illustrated. Published by John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1944. Price $4.00.

This text presents the mathematics required for the intelligent pursuit of elementary engineering courses and serves as a preparation for a course in the calculus. It contains those topics for algebra, trigonometry, and analytic geometry which are needed to meet this dual objective.

While the book is intended to be used with students who have had at least two years of high school mathematics, it is completely self-contained and relies wholly upon the usual simple facts from arithmetic and geometry. Since the necessary facts from geometry are collected in the Appendix, it is possible to use the book successfully with intelligent students who have had very little mathematical training beyond ordinary arithmetic, or who have largely forgotten their high school mathematics. This also makes the book an excellent one for home study and practical engineers who feel the need of a greater knowledge of mathematics should find the book useful.

Certain features of the book are designed to make it especially adapted to engineering curricula. Principles of accuracy in numerical computations are discussed in the first chapter, and the student is reminded of them throughout the text. The slide rule is discussed in the first chapter, and the student can use it to solve problems throughout the text. Graphical methods are stressed. Since the trigonometric functions are needed early in most physics and engineering courses, they are introduced early in the book. A chapter on vector algebra is placed early in the text. The graphs of the trigonometric functions are discussed fully. The Doolittle method of solving simultaneous linear equations is treated. Two introductory chapters on differential and integral calculus are supplied for use in courses where the fundamental ideas of the calculus are needed. There is a great abundance of exercises for the student, many from engineering and the physical sciences.

The authors are all instructors at the Illinois Institute of Technology and much of the material contained in the book was developed and used by the authors in the mathematics section of the training courses in communication engineering offered to members of the Signal Corps Reserve by the Illinois Institute of Technology.

Industrial Electronic Control. By W. D. Cockrell. First edition, 247 pages, 5½ by 8½ in., cloth, illustrated. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 18, N. Y., 1944. Price $5.00.

This book is intended as a guide for men in industrial plants in obtaining a better understanding of electronic control circuits for industrial uses. It is a book which gives the fundamentals of electron tube operation and shows how these fundamentals are applied in the basic circuits used in present day industrial electronic control devices. In a practical, non-mathematical treatment it explains various types of electron tubes, fundamental circuit components, basic electronic circuits, and the analysis of the complicated circuits used in modern industrial practice. It is intended to give the electrical man a sound, practical background in the important and rapidly growing field of industrial electronics.

The author has, for a number of years, been engaged in the Industrial Engineering Divisions of the General Electric Co., as a consequence the material which he presents in this book is strictly up-to-date. The text has been limited to electron circuits. Magnetic control, optics, and mechanical engineering are not given any particular attention even though knowledge of these subjects is required for successful application engineering.

The material in the book has been used successfully in the classes in industrial electronic control given to engineers at the General Electric Co. The functions of the various tubes as integral parts of circuits are stressed, rather than the phenomena taking place within the tubes themselves. Industrial symbols for electronic and electrical devices are used throughout so that they will be familiar when found on wiring diagrams. An interesting feature which characterizes the first part of the book where the various types of tubes used are described, is the presentation in connection with each tube not only of the elementary symbol denoting that tube, but also the wiring diagram as one would find it in the tube manuals. All explanations are brief, and mathematical formulas of interest only to designers are avoided. The more common circuit components and elementary circuits are described separately and then

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combined to assist the reader to analyze a complicated circuit.

The author is frank in stating that the material presented is not new. His primary aim has been to arrange the essential material in as compact and logical form as possible, to avoid excessive duplication of circuit detail, and to omit those items and applications which are of only casual interest to the industrial user.

An appendix includes sections on symbols and the color code ohmic values of resistance and reactance, photoelectric phenomena, and presents a number of charts illustrating standard curves and rectifier shapes.

The book should be of particular value to industrial engineers who have not had a great deal of background in the electronic field.

STATEMENT of the ownership, management, circulation, etc., required by the Acts of Congress of August 24, 1912, and March 3, 1933, of POWER PLANT ENGINEERING, published monthly at Chicago, Illinois, for October 1, 1944,
State of Illinois, } ss.
County of Cook, }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Kingsley L. Rice, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the Power Plant Engineering and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Technical Publishing Company, Chicago, Ill.

Editor, R. E. Turner, Chicago, Ill.

Managing Editor, Andrew W. Kramer, Chicago, Ill.

Business Manager, Kingsley L. Rice, Chicago, Ill.

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(This information is required from daily publications only.)

KINGSLEY L. RICE,
Business Manager,

Sworn to and subscribed before me this 25th day of September, 1944.

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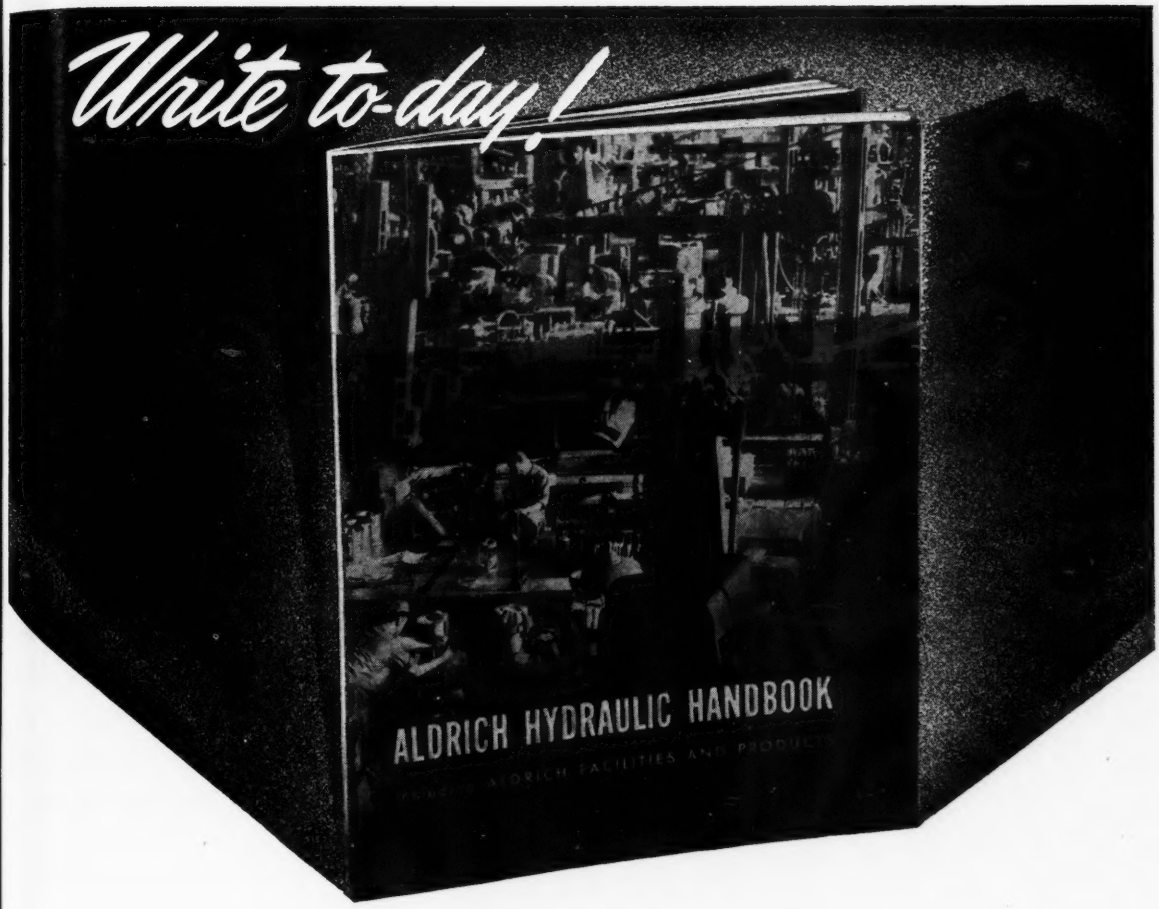

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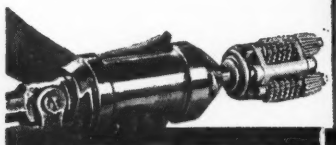
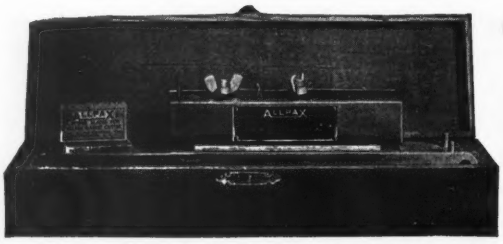
With ordinary tube cleaners, cleaning the front ends of tubes is a dangerous operation, even with perfect coordination between operator and helper. There is a natural tendency to insert the cleaner far enough inside the tube to eliminate any danger from revolving cutters when the air is turned on, thus leaving the front ends of tubes uncleaned.

With a Roto Tube Cleaner equipped with air valve directly behind the motor, the operator himself turns the air on and off. This positive one-man control permits him to turn on as much air as he needs, whenever he needs it, and he can clean right up to the end of the tube with complete safety. Get details of these time- and labor-saving tube cleaners.



ROTO Tube Cleaners

The ROTO Company, 145 Sussex Ave., Newark 1, N. J.
A DIVISION OF ELLIOTT CO.



Cuts your gasket costs in half

The most remarkable tool ever invented

Write for booklet

THE ALLPAX GASKET CUTTER

Manufactured by
THE ALLPAX COMPANY, INC.
Distributors everywhere — *Mamaroneck, N. Y.*

Troubled with FIRE-SCALE and SOOT?

Use XZIT

FIRE-SCALE AND SOOT ERADICATOR

Today, few power plants can afford to waste time and labor to remove fire-scale and soot by old manual methods. Xzit reduces these fuel-wasting deposits chemically, so they may be dissipated automatically by natural draft or blowing.

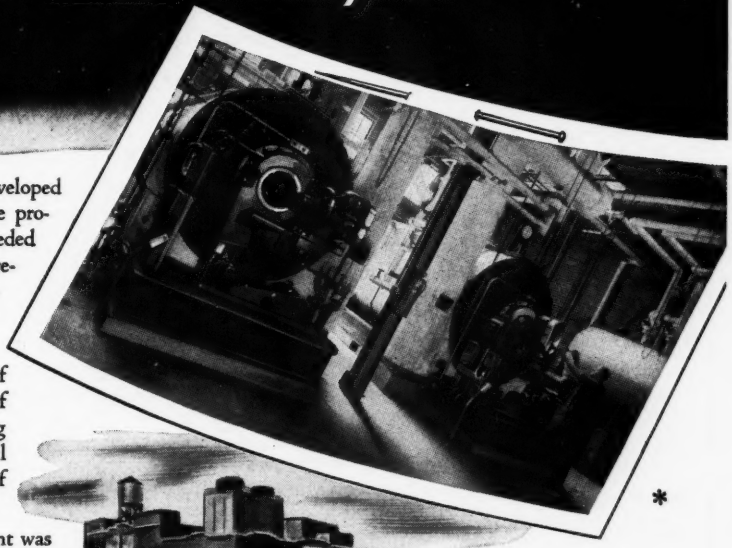
By simply feeding it into the fire-box while the boiler is in operation, Xzit keeps heating surfaces clean, reduces blowings, maintains uniformly higher boiler temperatures and lower stack temperatures, and reduces maintenance.

Write for Xzit sample or demonstration in your plant.

XZIT SALES CO.
1031 Clinton St., Hoboken, N. J.

P E N I C I L L I N

That the Drug of Mercy may be More Plentiful!



SCIENCE discovered it. Research developed it. Exigencies of war forced volume production. Penicillin was so urgently needed by the armed forces our government requested increased facilities for its manufacture as rapidly as was humanly possible.

And within a remarkably short space of time, the large modern penicillin plant of Chas. Pfizer & Co. Inc., manufacturing chemists, was built, equipped and in full operation producing large quantities of this vitally-needed drug.

Cleaver-Brooks' part in the achievement was the installation of two Cleaver-Brooks steam generators of the type successfully used in hundreds of other modern, progressive manufacturing plants. The Company wrote us:

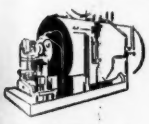
"The very short time in which we were able to complete the plant was due, in no small measure, to the prompt deliveries made by suppliers such as yourselves, which aided us in meeting the needs of our armed forces. We want you to know that we recognize and appreciate the important part you played in helping us to make this excellent record."

CLEAVER-BROOKS COMPANY
Dept. 5136, MILWAUKEE 9, WISCONSIN

* The Cleaver-Brooks installation in Chas. Pfizer and Company's modern penicillin plant in New York consists of two 300 H. P., 200 lb. working pressure, CLEAVER-BROOKS Steam Generators. These units are compact, factory-assembled, oil-fired, and operate at a high thermal efficiency. Automatic operating features and complete combustion assure cleanliness and lowest operating and maintenance cost.

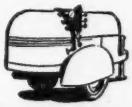
Cleaver-Brooks
STEAM GENERATORS

CLEAVER-BROOKS PRODUCTS INCLUDE:

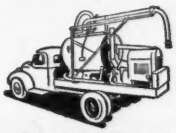


Steam Generators

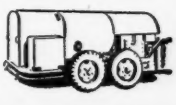
Food Processing Equipment



Tank Car Heaters



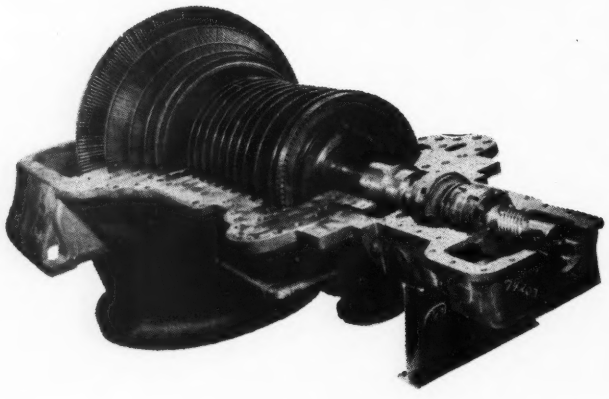
Bituminous Boosters



Special Military Equipment

MURRAY

MULTISTAGE STEAM TURBINES



This internal view shows the ruggedness, design, and fine workmanship that is built into every Murray turbine, from the largest to the smallest of units. While the machine shown was for generator drive, similar designs may be furnished to drive centrifugal compressors or pumps in the larger sizes.

Four 2500 KW 3600 RPM straight condensing turbines, designed to operate on steam at 600 pounds initial pressure, 750 degrees total temperature and exhausting to 29 inches Hg. vacuum were furnished to a Mid-Western plant a number of years ago, together with a number of smaller units for auxiliary drive.

Consider MURRAY for your prime movers for that new plant, or expansion. There is a MURRAY Representative handy to help you plan. He will welcome your problem.

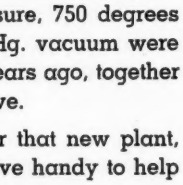
MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

BUILDERS OF STEAM POWER EQUIPMENT FOR THREE QUARTERS OF A CENTURY

"Boiler Repairs Reduced 75%"

writes user of **NATIONAL GIRTH SEAM PROTECTOR**



We have been using the National Girth Seam Protector for several years and they certainly do the job. . . . Have reduced our boiler repairs at least 75% since using these protectors, one of the best investments we ever made.

Von Platen-Fox Co.
Iron Mountain, Mich.

You, too, will find the National Girth Seam Protector saves trouble and money by preventing leaks and fire-cracking on new or old seams in boilers. Sections consist of wedge nut, cap screw metal lug and refractory covering; are easily attached. We can make immediate deliveries. Send for descriptive bulletin.

NATIONAL BOILER PROTECTOR CO., 740 REIBOLD BLDG., DAYTON, OHIO

Your Blueprint for

MORE POWER

starts with

OAKITE CLEANING

Controlling Slime In Air Conditioning Equipment . . . . . .

To prevent slime from forming in air-wash chamber, spray heads, piping, pump or drain of air conditioning units, many power plants find that treating the recirculating water with Oakite Airefiner proves highly effective.

This specially designed material for closed systems is merely added to the water supply as directed. In some installations it may first be necessary to remove any accumulated deposits. For this purpose, preliminary cleaning with fast-working Oakite Composition No. 22 removes slime accumulations, quickly restores system to normal operating condition.

Free 16-page manual gives details. It also tells how to remove impinged deposits from washable air filters . . . de-scale water-cooled and water-circulating equipment. Write for your copy today.

OAKITE PRODUCTS, INC.
23 Thames Street, New York 6, N. Y.

Technical Service Representatives Located in All Principal Cities of the United States and Canada

OAKITE *Specialized cleaning*

Buy Bonds for Victory

MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

AN INFORMATIVE BULLETIN

ON A NEW HEAT EXCHANGER DESIGN

The bulletin illustrated on this page is the latest literature by Davis Engineering Corporation on its new *Self-Cleaning Tubular Heat Exchanger.* It explains and illustrates graphically, in color, the design and operating principle of this Paracoil Tubular Heat Exchanger.

The Self-Cleaning Heat Exchanger, however, is but one of several standard and special Paracoil Heat Exchanger designs adaptable to many heat exchange operations throughout industry. If your plant has a special heat exchange problem, we invite you to consult us.

For special heat exchange applications, engineers and operating men are referred to the bulletin shown below. Ask for Bulletin HE-100.

Paracoil

HEAT EXCHANGE EQUIPMENT

BLOWDOWN EXCHANGERS
BOILERS
exhaust gas—waste heat
CONDENSERS
CONVERTORS
COOLERS
condensate—jacket water—lubricating oil—quenching oil—solution
DISTILLING PLANTS
EVAPORATORS
EXCHANGERS
liquid to liquid—liquid to gas—solution
EXTRACTORS
grease—boiler feed water
HEATERS
instantaneous—feed water—solution — fuel oil — storage water
TRAPS
steam
VALVES
cross and three-way—exhaust gas by-pass

DAVIS ENGINEERING CORPORATION 1068 EAST GRAND ST., ELIZABETH 4, N. J.

Steam Trap Economy Starts Here

Super-Silvertop can be piped as an elbow or straight-in-line.

True Steam Trap economy starts with a blueprint calling for Super-Silvertop traps to drain off condensate on new steam using equipment. Why? Because their installation brings a saving on fittings . . . a saving also on labor costs since each trap requires 60 minutes less installation time . . . and they can be inspected without removing from the line. Multiply these economies by the number of traps installed and the saving over the years is startling . . . You will find other economies in the free book, "How to Choose a Steam Trap."

THE V. D. ANDERSON COMPANY
1939 West 96th Street • Cleveland 2, Ohio

Super-Silvertop
STEAM TRAPS

Waste Pipes Clogged Up?

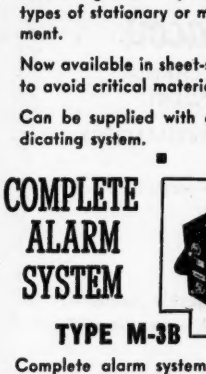
"MILLER'S" Cleanout Tools are used all over the country by leading engineers for clogged up Drains, Gas Lines, Chemical Lines, Sewers and Toilets. This Miller unit is one of the most efficient ever produced. The high speed gear handle whirls a strong flexible rod through bends, angles, traps and elbows—driving through stoppages in a jiffy. It will use a ¼-inch, ⅜-inch, or $\frac{5}{16}$-inch rod and accommodate as much as 30 feet. Guaranteed to do the job.

Send For Our New Catalog Today

J. C. MILLER TOOL SALES
5914 Wilson Ave. Chicago 30, Ill.

VIKING

ENGINE *ALARM* SYSTEMS



TYPE M

CONTACT MAKERS

Pressurestatic or Thermostatic Contact Makers for lubricating-oil or circulating-water systems for all types of stationary or mobile equipment.

Now available in sheet-steel housing to avoid critical materials.

Can be supplied with complete indicating system.

COMPLETE ALARM SYSTEM

TYPE M-3B

Complete alarm system consists of Type M-3B combination pressure control, junction box and visual indicator, together with Type M Thermostatic Contact Maker, and signal howler.

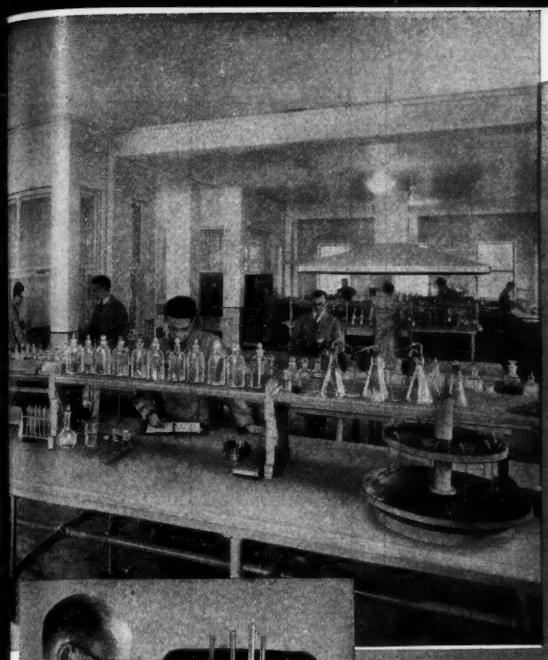
WATER- AND WEATHER-TIGHT

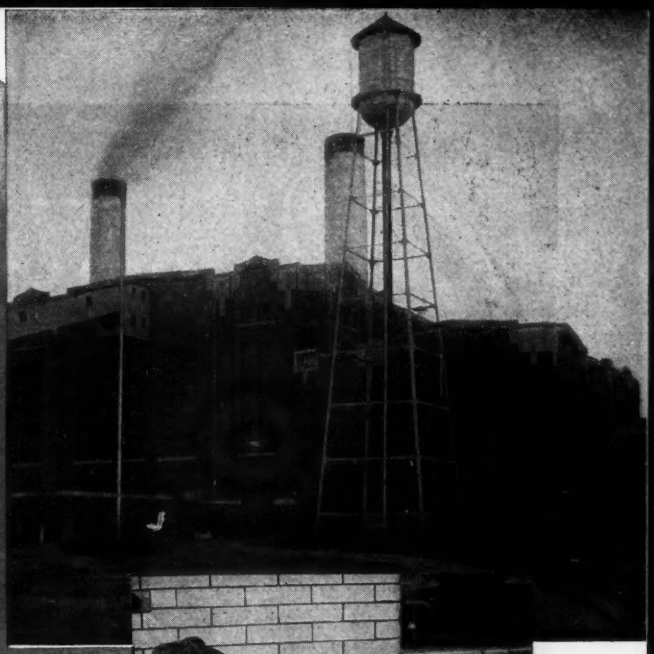
TYPE C
CONTACT MAKERS

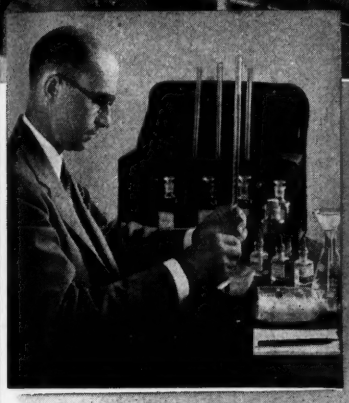
Where Contact Maker is exposed or must be waterproof, Type C Pressurestatic or Thermostatic is recommended.

Manufacturers of engine alarm systems, annunciators, marine and industrial instruments. Write for specifications.

VIKING INSTRUMENTS, INC.
403 Fairfield Ave., Stamford, Conn. Telephone 4-7378







(Left) The Chief Technical Engineer is the contact between your plant, the Dearborn Service Engineer, and Dearborn Laboratories. He writes the recommendations.

(Right) The Dearborn Engineer is always nearby and subject to your call. He works in your boiler room with your men to get the best results. He is the water expert on the job.

YOU NEED NO PRIORITY TO ADD THIS LAB TO YOUR FACILITIES

● Preparation for properly conditioned boiler water starts when the Dearborn Engineer goes on location and makes survey and water tests right in your own boiler plant. From there, water samples go to our laboratories where they are analyzed.

The coordinator of all these findings, the Chief Technical Engineer at the Dearborn Laboratories, then works out a formula to fit *your* conditions, recommends the proper dosage to be used, and suggests methods of application to be supervised by the Dearborn Service Engineer.

Here is a complete cycle of efficiency that adds the full facilities of the great Dearborn Laboratories to your own facilities, whether you have water chemists in your employ or not.

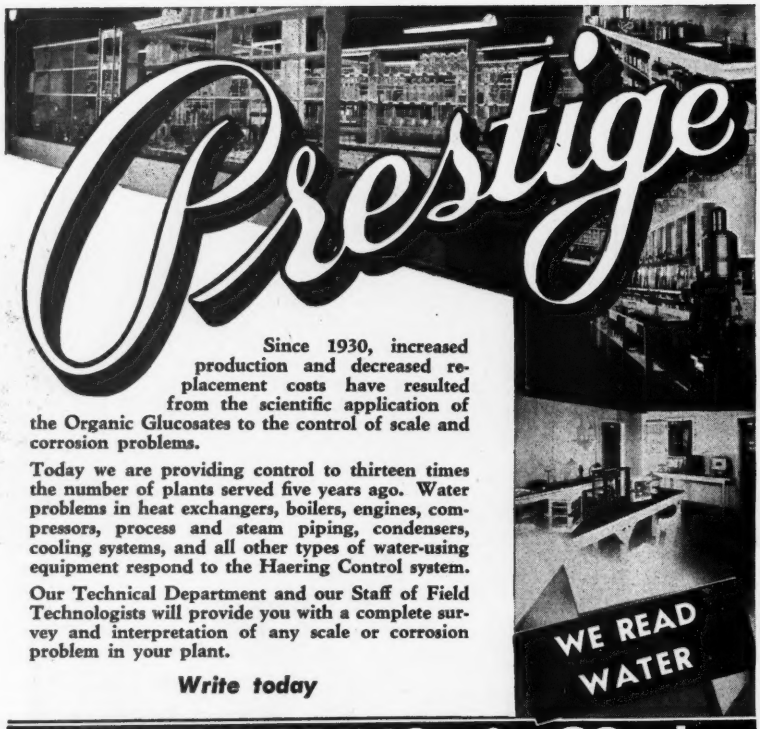
There is a Dearborn Service Engineer nearby to serve you. Get in touch with him or direct with us.

Dearborn

TRADE MARK REGISTERED

BOILER WATER TREATMENT AND SERVICE

DEARBORN CHEMICAL COMPANY
Dept. F, 310 S. Michigan Ave.
Chicago 4, Illinois



Since 1930, increased production and decreased replacement costs have resulted from the scientific application of the Organic Glucosates to the control of scale and corrosion problems.

Today we are providing control to thirteen times the number of plants served five years ago. Water problems in heat exchangers, boilers, engines, compressors, process and steam piping, condensers, cooling systems, and all other types of water-using equipment respond to the Haering Control system.

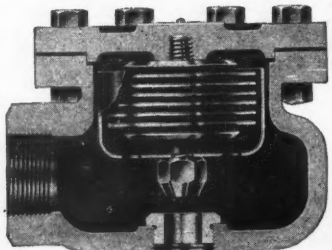
Our Technical Department and our Staff of Field Technologists will provide you with a complete survey and interpretation of any scale or corrosion problem in your plant.

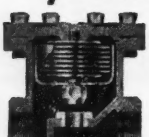
Write today

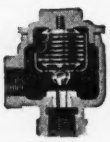
D. W. HAERING & CO., Inc.
GENERAL OFFICES
205 West Wacker Drive, Chicago 6, Ill.

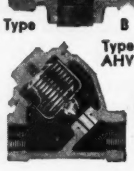
WHAT OTHER TRAP

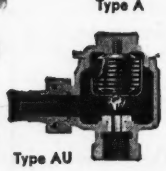
offers ALL of these features











NO AIR-BINDING—Discharge air as efficiently as water. . . . NO FREEZE-UPS—Drain when cold. . . . NO ADJUSTMENT, for any pressure. . . . NO WATER-LOGGING—A few degrees temperature differential opens valve . . . NO DRIBBLING—Close immediately when steam contacts bellows.

5 Types of Nicholson Industrial Thermostatic Steam Traps

Sizes ¼" to 2". 2 to 6 times greater valve area and discharge capacity. Pressures to 225 lbs. Write NOW for Bulletin No. 843. . . . See Our Catalog in Sweet's.

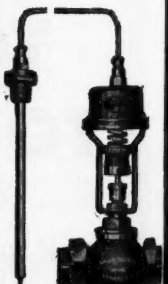
W. H. NICHOLSON & CO. 160 OREGON ST. WILKES-BARRE, PA.

Valves • Traps • Steam Specialties

DON'T WASTE FUEL

Save it with

ATLAS
Temperature Regulators



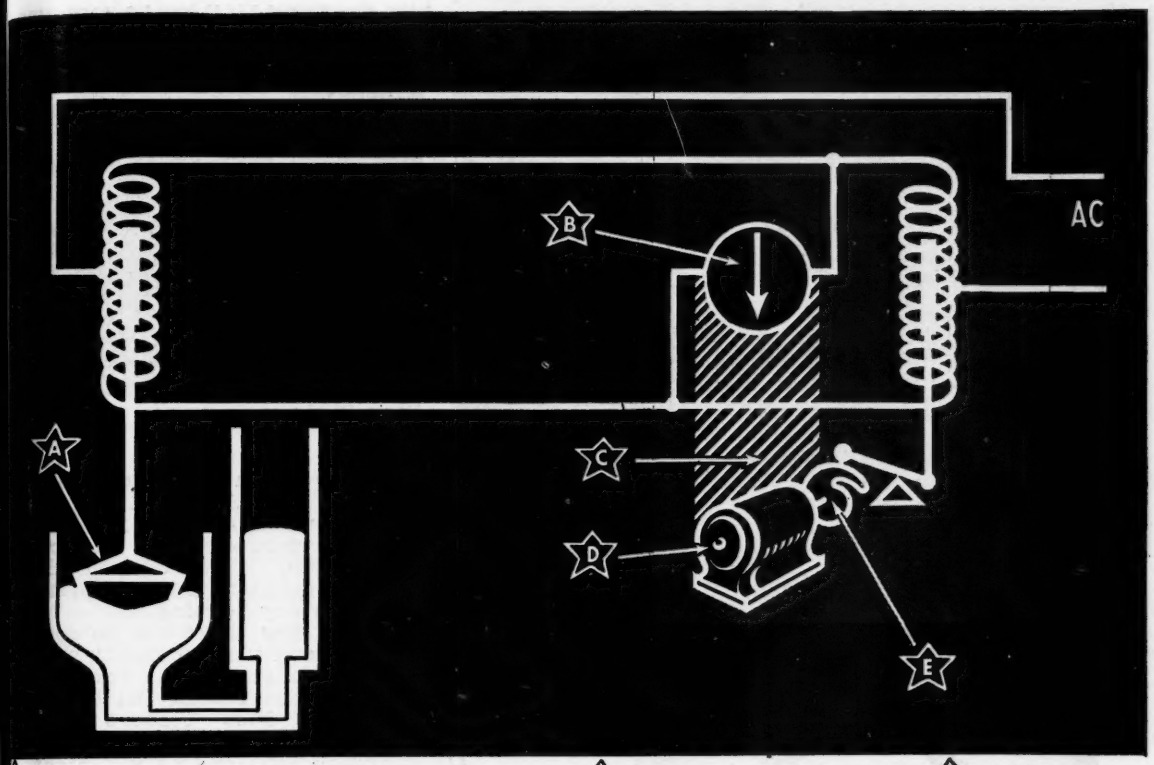
It's both sensible and patriotic to see that only the exact amount of heat needed goes into your liquids in open or closed tanks, heaters, etc.

The ATLAS Type 650, pictured here, comes in sizes ½" to 2½". Easy to install and adjust. Both bulb and control valve will operate in vertical or horizontal position. Equipped with seamless metal bellows. Suitable for use with low or high pressure steam.

For data on other ATLAS Temperature Regulators see our ad in the May 1944 issue of this journal, or better still write for Bulletin 7A for complete information.

ATLAS VALVE COMPANY
REGULATING VALVES FOR EVERY SERVICE

291 South St. Newark 5, N. J.
Representatives in Principal Cities



(A) Friction-free Transmitter. Float rests on surface of mercury. (B) Sensitive Jeweled Galvanometer. (C) Mechanical Relay. (D) Powerful Auxiliary Motor. (E) Calibrated Cam insures uniform accuracy.

Study this diagram

Movement of the float (indicating difference in rate of flow) is detected by the sensitive galvanometer (B) which causes the mechanical relay (C) to actuate the powerful auxiliary motor (D) bringing the receiver core to the same position as the transmitter core, and moving pen arm, indicator and integrator to record the change in flow.

No other flow meter has this simple, friction-free principle. It follows that for matchless ACCURACY you need only specify the Cochrane Flow Meter.

It explains the matchless ACCURACY of the Cochrane Flow Meter . . .

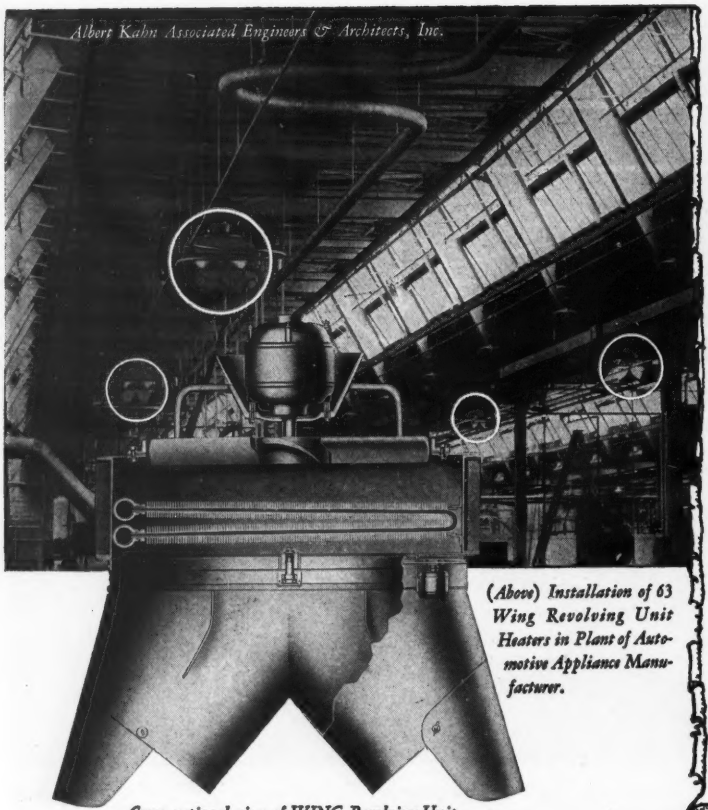
We print this diagram as large as we can get it for a very good reason. Once you understand the basic principle of the Cochrane Friction-Free Electric Flow Meter, the secret of its matchless Accuracy becomes plain. Because flow meter accuracy is attained first, by eliminating friction at the manometer and second, by applying ample power to overcome inherent friction in the receiver. Note how friction has been eliminated in the Cochrane manometer. The float rests on the surface of the mercury in the high pressure leg of the manometer, positioning the magnetic core between two reactance coils. There are no stuffing boxes, no bearings, no electric contacts, no solenoid reactions.

Write for a copy of Publication 3010 "Flow Meters by Cochrane."

COCHRANE CORPORATION
3123 N. 17th ST., PHILADELPHIA 32, PA.

COCHRANE

SOFTENERS · DEAERATING SOFTENERS · DEAERATORS · METERS · STEAM SPECIALTIES

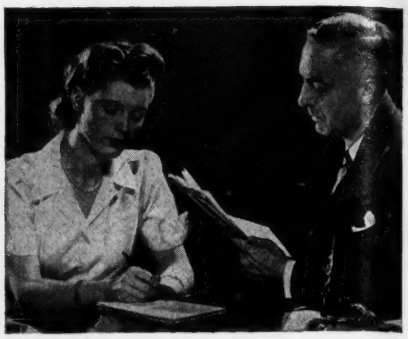


Albert Kahn Associated Engineers & Architects, Inc.

(Above) Installation of 63 Wing Revolving Unit Heaters in Plant of Automotive Appliance Manufacturer.

Cross-sectional view of WING Revolving Unit Heater, showing Motor, Fan, Heating Element and Revolving Discharge Outlets.

ONE FACTORY MAN TELLS ANOTHER:



Dear Bill:

You ask about our experience with Wing Revolving Heaters. Well, all I can say is that until our heating contractor persuaded us to install them, I was continually hearing complaints about unsatisfactory heating.

Now there are no complaints and work actually seems to go more smoothly. Our heating contractor said unit cost would be less because fewer heaters were needed to do a thorough job..and he was right.

WING *Revolving* HEATERS

ELIMINATE HOT SPOTS AND COLD SPOTS

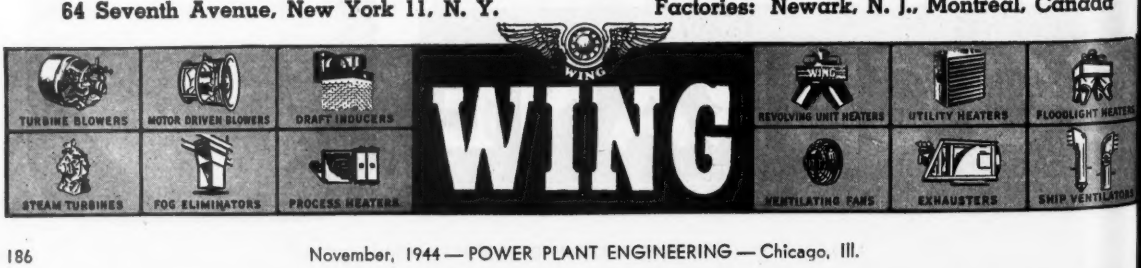
Bring a new sensation of fresh, live, invigorating warmth

The remarkable feature of Wing Revolving Unit Heaters that distinguishes them from all other types of heating systems is the fact that the discharge outlets *revolve*. This fundamental difference is the reason for the thorough uniform coverage attained in plants where they are installed, and the surprising and pleasing sensation of fresh, live, invigorating warmth enjoyed by the workers. This effect on the workers is a great aid to production, which applies all year round, for in summer, with the steam turned off and the fans on, these revolving discharge outlets provide a cooling effect that is equally effective in accelerating production.

Write for Bulletin HR-3

L. J. Wing Mfg. Co.

64 Seventh Avenue, New York 11, N. Y. **Factories: Newark, N. J., Montreal, Canada**



HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail.

BOILER PLANT

1 **Spreader Stokers** — Bulletin No. 78 describes the Fyr-Feeder multiple spreader type stoker under the theme "burns coal like oil." The principle of the multiple spreader stoker is included with detailed illustrations and installation data. American Coal Burner Co.

2 **Quick Steam-Cost Calculator** — Steam plant operators will want this quick steam-cost slide rule calculator. Figures steam costs for both oil or coal. Cleaver-Brooks Co.

3 **No-Vent Boiler Return** — Bulletin explains how Stout no-vent boiler return system runs continuously, collects condensate as fast as formed, saves fuel. Also shows guarantee chart. David Stout & Sons.

4 **Unit Type Stoker**—Bulletin No. 600 tells about savings of Detroit Uni-Stokers in various industrial plants. These single retort, plunger feed, unit type stokers are flexible in operation, burn all grades of coal, serve boilers 125 to 300 hp. Detroit Stoker Co.

5 **High Temperature Bonding Mortar** — Three new bulletins on air setting high temperature bonding mortars describe: 1—Super Ignisite, for use where ordinary high temperature mortars fail, 2—Wet Ignisite and 3—Dry Ignisite, for use in annealing furnaces, boilers, heating furnaces, foundry cupolas, coke ovens, lime and cement kilns, oil stills, electric furnaces, etc. Refractories Division of the M. W. Kellogg Co.

6 **Packaged Power Plant** — Bulletin No. 1213 pictures and describes the new O & S Powermaster. This automatic oil-firing steam generating plant saves floor space, is easy to transport and install. Sizes 10 to 100 hp. Orr & Sembower, Inc.

ELECTRICAL

7 **Practical Design for Arc Welding** —Work sheets 17 to 24 furnish helpful hints on arc welding corrosion resisting linings for pressure vessels, fan rotor, generator base, commutator shell, tube joints in truss construction, etc. The Hobart Brothers Co.

8 **Fungus Resisting Impregnating Varnish**—Folder describes Synthite PG-4-FC clear baking varnish for all types of electrical windings. Unlike conventional surface coating, PG-4-FC protects each layer of wire. If surface of winding is damaged in rough handling, the fungicidal protection of the varnish is still retained. Curing of PG-4-FC Synthite varnish takes place through heat induced chemical polymerization which brings about complete solidification of the entire mass. John C. Dolph Co.

9 **Electronic Availability Lists** — Walker-Jimieson publish each month an Industrial Availability Booklet showing items available on priority for immediate delivery. Lists such items as tubes, test equipment, timers, relays, x-ray machines, constant voltage transformers, condensers, resistors, flashlight storage batteries, pencil soldering irons, industrial switches, photo electric units, fluorescent lamps, plastic wiring systems.

10 **Dry-type Transformers**—Bulletin GEA-897 describes Type D transformers, installed right at the load, provide the right voltage for most economical operation of equipment they serve. Small, compact, lightweight—easy to install and maintain. Available in ratings up to 100 kva, 600 volts. General Electric Co.

11 **Circuit Breaker Bulletin**—"Keeping Air Circuit Breakers in Trim" is the title of Bulletin No. 4403, recently published by the I-T-E Circuit Breaker Co. "Breaker won't stay closed?"—"Contact impression? What's that?"—"How much oil in the time-delay cups?"—are only a few of the questions answered.

12 **Subway Distribution Transformers** —An expanded line of distribution transformers designed to withstand complete submersion in water are described in new bulletin issued by the Allis-Chalmers Mfg. Co. Built for use in underground vaults and similar locations, the subway distribution transformers operate under these conditions without damage to themselves or interruption to service. Available in standard sizes—10 to 200 kva—and standard voltages.

FANS, PUMPS, COMPRESSORS

13 **Facts About Rotary Pumps**—Bulletin No. 304 pictures operating cycle, buckets, rotor and other features of Blackmer rotary pumps. Also shows single unit, twin unit, V-belt and various pump types; contains capacity curve and other useful data. Blackmer Pump Co.

14 **Compressed Air After-Cooling** — Bulletin 98 contains interesting color chart on new method of keeping water and oil out of compressed air. Also lists capacities of Niagara Aero after-cooler. Niagara Blower Co.

15 **Centrifugal Fire Pumps** — A new line of single-stage, double-suction fire and booster pumps designed for efficient, low-cost fire protection has been announced by Allis-Chalmers Mfg. Co. in a recent bulletin. Pumps are approved for heads ranging from 60 psi to 108 psi at capacities ranging from 500 gpm to 1500 gpm.

16 **Feather Valve Compressor** — With brief text and interesting colored sectional views, Bulletin 1-667-B1 describes the construction features and operating advantages of Worthington feather valve compressors. These compact units are said to require one-fourth the foundation normally required for same capacity horizontal compressor. Worthington Pump and Machinery Corp.

INSTRUMENTS AND CONTROLS

17 **Electronic Feed Water Control**—Catalog 51A describes the Fireye electronic method of boiler feed water regulation—floatless and easy to maintain. Combustion Control Corp.

18 **Photoelectric pH Determination**—New bulletin tells why Lumetron colorimeter is particularly suited for photoelectric pH determinations. It is independent of human judgment; is simple, accurate, direct reading. Photovolt Corp.

19 **Ratio Control for Proportioning**—Bulletin No. 101 points out the manner in which Askania Ratio Control may be applied to many types of proportioning applications in the process industries. A novel feature of the bulletin is the orifice calculation chart. This offers engineers a quick and easy method of orifice size determination for air and gas flows. Askania Regulator Co.

20 **Welding Regulator**—New bulletin illustrates design and construction features of Victor single and two-stage reduction regulators employed in the welding industry. It shows engineers and welding department heads practical details often hidden from the view of the prospect. Victor Equipment Co.

MECHANICAL TRANSMISSION

21 **Speed Reducer Handbook**—"Data Book on Worm Gear Speed Reducers for Industrial Applications" has 100 pages, replete with photographs, dimensioned line drawings, engineering data, horse power ratings, and tables of weights and dimensions, all aimed at helping the engineer to make his own selection of the type and size of reducer required for a specific service. Link-Belt Co.

22 **History of Power Transmission**—"From the Shadoof to the Dominant Drive" is a thumbnail history of man's effort to transmit power. Answers such questions as: What factory first used iron pulley wheels, what nation developed the flat belt, how old is V-belt drive? Multiple V-Belt Drive Assoc.

23 **Flat-Belt Drives** — 24-pg catalog gives you complete information on American steel split pulleys and bushings, shaft collars, shaft hangers and bearings, split and solid conveyor pulleys, hi-torque motor pulleys, belting and Econ-o-matic drives for short-center flat-belt drives. Application, design and advantages of group drives are also discussed. The American Pulley Co.

24 **Data on Flexible Couplings**—New Bulletin No. 150 contains ratings, dimensions, construction features of Philadelphia steel flanged and other couplings. Also helpful suggestions on selecting correct sizes for given installations. Philadelphia Gear Works.

25 **Manual on V-Belt Drives** — New 72-pg Master Manual contains original engineering data sectionalized, looseleaf, tabbed for ready reference; helps you select in three minutes the right Worthington V-Belt drive. Specification and installation record sheets included. Worthington Pump and Machinery Corp.

PIPING, VALVES AND FITTINGS

26 **Steam and Compressed Air Traps** —Catalog 444 furnishes complete data on the Nicholson line of piston and weight-operated steam traps and compressed air traps. W. H. Nicholson & Co.

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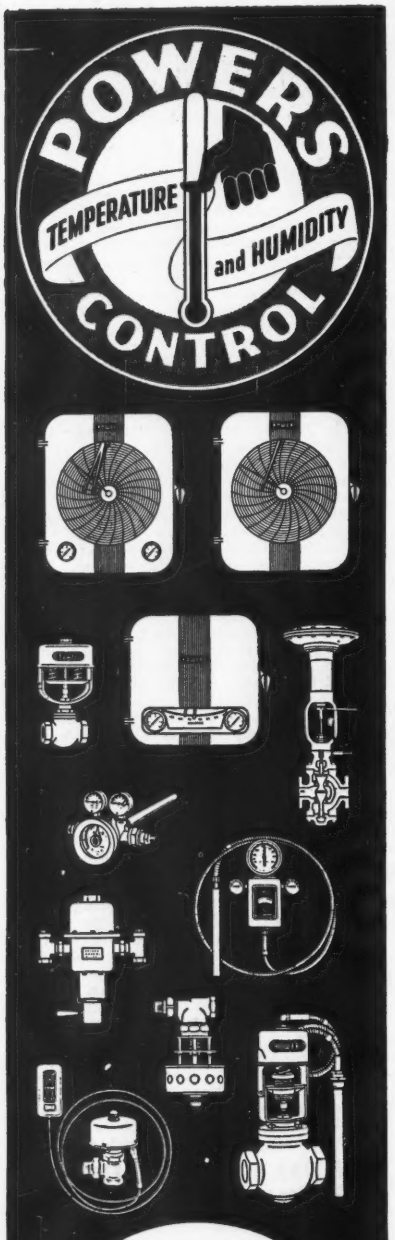

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27 Butterfly Valves—New 4-pg illustrated Bulletin No. 16-B contains complete dimension tables for butterfly valves, 15 to 125 psi. Features valves for regulation and shut-off duty for air, gas, steam, liquids and semi-solids—manual and automatic control. Issued by R-S Products Corp.

28 Conduit Installation Handbook—In addition to comprehensive descriptions of Ric-wiL products, new catalog No. 44 contains a great deal of information of value to architects, engineers and heating contractors who are concerned with the problem of insulation and protection of piping—either underground or overhead. Capacity tables, trench dimensions and general specifications are included for Ric-wiL prefabricated insulated pipe units and for tile or cast iron conduit systems. The Ric-wiL Co.

29 Steam Trap Handbook—Tables, charts, diagrams and rules for selecting traps, giving complete explanations, make the new 36-pg Armstrong Steam Trap Book a handy reference volume for every engineer's library. Armstrong Machine Works.

WATER TREATMENT

30 Hot Process Softeners—Attractive 24-pg bulletin describes advantages and operation of hot process water softeners. Includes sectional views and hookups of equipment, installation photos, vertical tank capacities and other engineering data. Graver Tank & Mfg. Co.

31 Studies of Boiler Scale—"Experimental Studies of Boiler Scale at 800 psi" is the title of a reprinted article covering tests of boiler feedwater treated with calcium, magnesium, silica, alumina, phosphate. Photos show deposits under various operating conditions. National Aluminate Corp.

32 Acid Regenerated Carbonaceous Zeolites—Cochrane Reprint No. 32 covers theoretical considerations demonstrating characteristics of acid regenerated carbonaceous zeolites. The article summarizes extensive research work when using sulphuric acid as the regenerant and shows the characteristics of various salts, singly and in combination. Cochrane Corp.

MISCELLANEOUS

33 All-Aluminum Ladder — Lightweight, low maintenance cost, and safety are among the advantages of the new all-aluminum ladder being offered industry for the first time. Rubber top and bottom insulate against high voltages. Duo-Safety Ladder Corp.

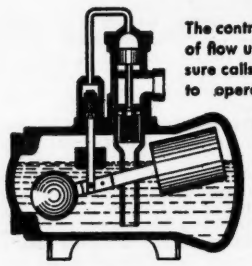
34 Vibration Control—New folder describes vibration control bases for engine generator sets, compressors, fans, motors and other mechanical equipment in buildings. Said to save up to 50 per cent of wear and tear on buildings and equipment. Vibration Control Co.

35 Ceiling Type Cooling Unit—Attractive folder tells about the Spasaver, a compact ceiling-type cooling unit for cold rooms and refrigerators. Contains construction blueprints, performance data on 10 sizes. Drayer-Hanson, Inc.

36 Factual Data About Plastics—"Polyethylene Resins," 12-pg brochure describes the forms, properties, fabrication procedures, and uses of this new group of thermoplastic materials. Interesting data tables present graphic summaries of the plasticity, electrical properties, and thermal expansion of this latest resin. In addition to electrical uses, polyethylene does well in other applications; outperforms rubber gaskets in cylinder valve packing. Plastics Division—Carbide and Carbon Chemicals Corp.

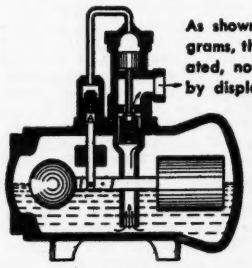
37 Open Steel Flooring—Well-illustrated Catalog No. 42-44 tells how Bates grates give the safety, strength, ventilation and cleanliness wanted in floors and stair treads for industrial plants. Contains many construction blueprints, installation photos, floor engineering data. Walter Bates Co., Inc.

How to Handle Condensate Drainage at High Pressures

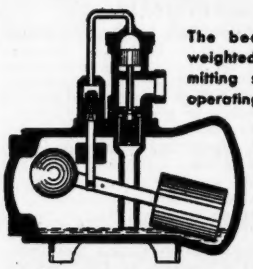


The control of a high rate of flow under high pressure calls for great force to operate the valve.

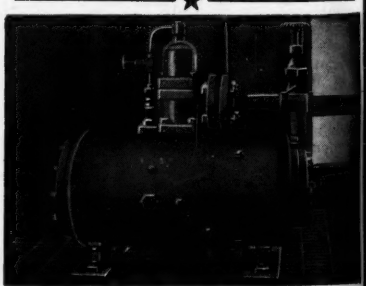
In the Cochrane Discharger this force is provided by a piston actuated by a pilot valve.



As shown in these diagrams, this pilot is operated, not by floats but by displacement bodies of different densities at either end of a beam which tilts with the rise and fall of the water level.



The beam opens the weighted pilot valve admitting steam to main operating valve which instantly opens main discharge valve to full opening, avoiding wire drawing or chatter.



Publication 2935 gives complete data.

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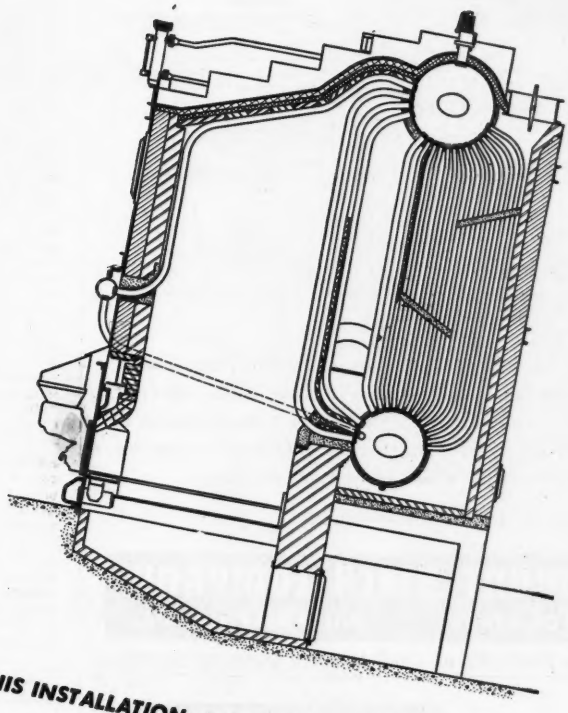

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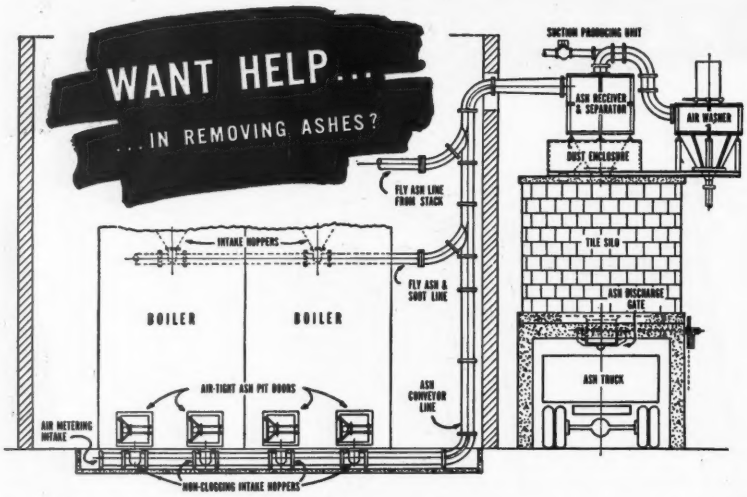

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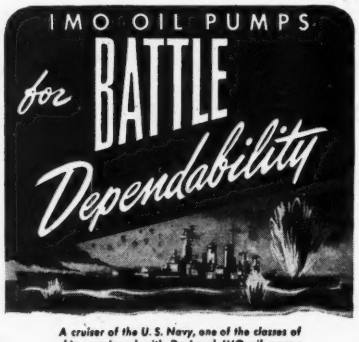

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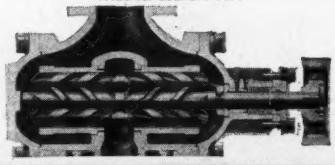

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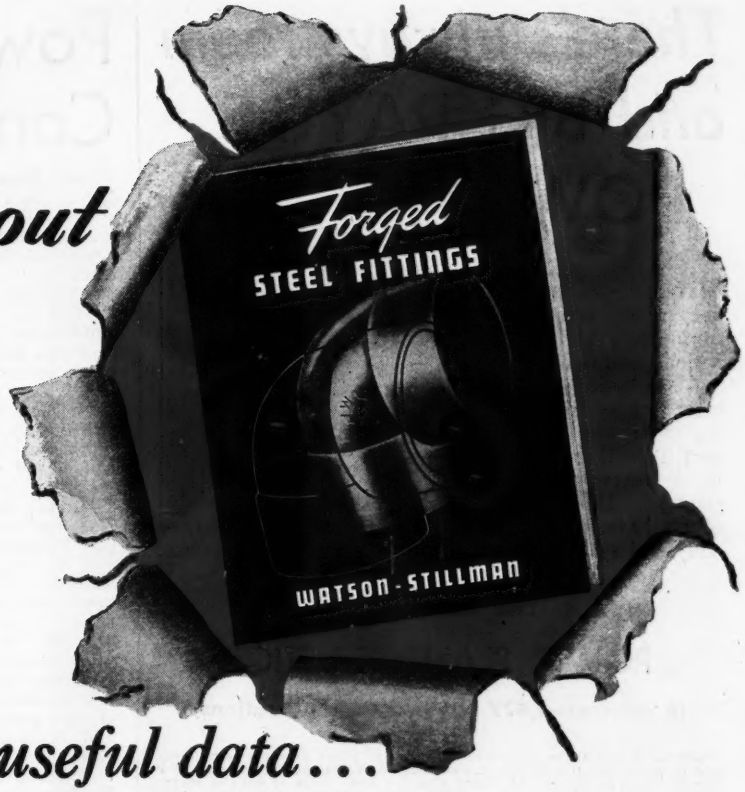

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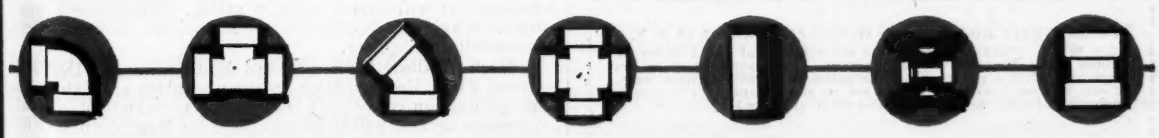

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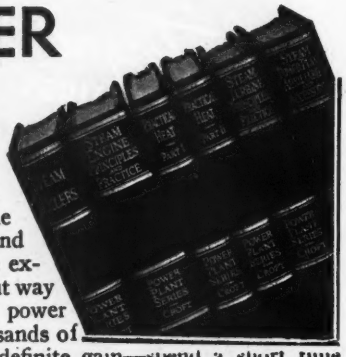

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Power Plant Construction News

Ala., Birmingham—Alabama Power Co., Alabama Power Bldg., plans postwar expansion program in rural electric system, totaling close to 5000 miles of primary and secondary lines in different parts of State. Work will include power substations and other operating facilities, and will be carried out over a period of months. Cost reported in excess of $4,500,000. Company has plans maturing for new transmission line from Cuba to Riderwood, Ala., over 25 miles. Application has been made for permission.

Colo., Denver—Ford Motor Co., Dearborn, Mich., plans new four-story assembling plant, about 200 x 400 ft, at Denver, where site near East 40th St. and line of Chicago, Burlington & Quincy R. R., has been acquired. Electric power equipment will be installed. A boiler house is planned for central-heating service. It is understood that project will be an early postwar development. Cost reported in excess of $650,000.

Conn., South Manchester—Cheney Brothers, Hartford Rd., manufacturers of rayon and silk fabrics, yarns, etc., plan installation of electric power equipment in connection with an expansion and modernization program at mill, including additional buildings, machinery and facilities for large increased output. Program will be carried out over a period of months and is reported to cost in excess of $500,000. H. K. Ferguson Co., Hanna Bldg., Cleveland, Ohio, is engineer.

Iowa, Hampton—Federated Cooperative Power Assn., has preliminary plans under way for three new Diesel-electric generating plants on sites near Dinsdale, Radcliffe and Allison, Iowa, respectively. Cost estimated about $200,000. Financing has been arranged through REA. It is understood that bids will be asked at early date. Stanley Engineering Co., Muscatine, Iowa, is consulting engineer.

Iowa, Waukon—City Council has engaged Stanley Engineering Co., Muscatine, Iowa, consulting engineer, to make surveys and estimates of cost for a proposed municipal electric light and power plant. It is understood that Diesel engine-generating units will be used. Project is scheduled as a postwar development.

Kansas, Great Bend—Central Kansas Electric Cooperative Assn., Inc., William J. Groh, manager, will have plans prepared soon for new electric generating station for power supply for rural electric system. Cost estimated about $430,000. Financing in that amount has been arranged through REA.

Ky., West Liberty—Licking Valley Rural Electric Cooperative Corp., K. H. Risner, general manager, plans extensions in primary and secondary lines in parts of Wolfe, Perry, Morgan and other counties, totaling about 250 miles in all. Cost estimated about $207,000. Proposed to begin work soon.

La., New Orleans—New Orleans Public Service, Inc., 317 Baronne St., has plans under consideration for expansion in Market St. generating station as a postwar project, including installation of a new turbine-generator unit and auxiliary equipment, boilers and accessory apparatus. Cost estmated close to $3,500,000.

Mass., Chelsea—Panther-Panco Rubber Co., Inc., 31 Highland St., manufacturer of rubber soles and heels, plans installation of electric power equipment in new one and three-story mill addition, about 150 x 675 ft, reported to cost in excess of $600,000. Production will be for Government and project will have a priority rating. Erection will begin soon. Waghorne-Brown Co., 44 School St., Boston, Mass., is consulting engineer.

Mich., Willow Run—Packard Motor Car Co., 1580 East Grand Blvd., Detroit, Mich., plans new plant at Willow Run for production of aircraft engines for Government. It will comprise several buildings, equipped for large output. Electric power equipment will be installed. Cost estimated about $750,000, with financing in that amount to be provided by Defense Plant Corp., Washington, D. C., Federal agency. Work will proceed at early date.

Minn., Brainerd—Benedictine Sisters Benevolent Assn., Duluth, Minn., care of P. M. O'Meara & Associates, 4908 Delmar Blvd., St. Louis, Mo., architects, plans new power plant at its St. Joseph Hospital, Brainerd, in connection with a new four-story and basement addition to in-

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The only hanger offering all these important features for high temperature piping support. Constant support of piping in all "hot" and "cold" positions – full safety factor of the supported system is always maintained • Mass produced from standard precision parts • Individually calibrated for each specific installation • Rated capacity of each model varies with the size of the springs used – overall dimensions of the hanger remain constant • Minimum headroom required.

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In this instance, as in many others, the Smooth-On method of repair prevented the danger of cracking or warping the head, which might have occurred from application of heat. With a few cents' worth of Smooth-On, and within five hours, the engineer saved a cylinder head costing $165.00 plus the lengthy time required to secure a replacement.

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stitution. Project will be carried out as a postwar development, and is estimated to cost over $450,000. Architects noted are in charge.

Minn., Maple Lake—Rural Cooperative Power Assn., Maple Lake, has plans under way for a proposed new Diesel-electric generating station, in connection with construction of new rural electric lines. Entire project is estimated to cost about $230,000. Financing in that amount has been arranged through REA. Ralph D. Thomas & Associates, 1200 Second Ave., South, Minneapolis, Minn., are consulting engineers.

Neb., Fremont—Department of Public Utilities, 734 North Park Ave., has plans nearing completion for proposed expansion and improvements in municipal power plant, including installation of new boiler unit, 2500-kw turbine-generator and auxiliary equipment. Cost estimated about $429,000. Project has secured a priority rating and bids are scheduled to be asked soon. Black & Veatch, 4706 Broadway, Kansas City, Mo., are consulting engineers.

N. Y., Jamestown—Municipal Light Department, City Hall, has engaged J. G. White Engineering Corp., 80 Broad St., New York, N. Y., consulting engineer, to prepare plans for proposed postwar expansion and improvements in municipal steam-electric generating station, recently referred to in these columns. Cost reported close to $2,000,000, including extensions in electrical distribution system.

Ohio, Warren—Packard Electric Division, General Motors Corp., manufacturer of wire and cable for aircraft, electrical and other service, has plans under way for new boiler house at plant, reported to cost in excess of $100,000, with boiler units and auxiliary equipment. Company engineer is in charge.

Pa., Conshohocken—Lee Rubber & Tire Co., plans installation of electric power equipment in new two-story addition to mill. Cost reported over $200,000, with machinery. Project has a priority rating and work will be placed under way soon.

Pa., Saegertown—Northwestern Rural Electric Cooperative Assn., Cambridge Springs, Pa., has plans nearing completion for new power substation at Saegertown, and will extend lines in that area. No estimate of cost announced. Gibbs & Hill, Pennsylvania Station Bldg., New York, N. Y., are consulting engineers.

S. D., Brookings—City Electric Department has engaged Charles Foster, Medical Arts Bldg., Duluth, Minn., consulting engineer, to make survey and estimates of cost for proposed extensions and improvements in municipal power plant, to be carried out as a postwar project. Work will comprise installation of new boiler and auxiliary equipment, switchboard and other electrical apparatus.

S. D., Estilline—Municipal Light and Power Department plans extensions and improvements in municipal power station, including installation of new Diesel engine unit and auxiliary equipment. Estimates of cost are being secured. It is understood that project will have a priority rating.

Va., Roanoke—Roanoke City Mills, Inc., plans installation of electric power equipment in connection with proposed rebuilding of feed and grain mills, recently destroyed by fire, with loss reported over $200,000. Application is being made for a priority rating. J. W. Ring is president.

Wash., Seattle—Todd-Pacific Shipyards, Inc., 2400 11th Ave., S.W., plans installation of electric power equipment and facilities in connection with extensions and improvements in local shipyard, including shipways and additional shop units. Entire project is reported to cost over $350,000. Work is scheduled to begin soon.

Wis., Kenosha—Nash-Kelvinator Corp., plans installation of electric power equipment in new one-story addition, 250x300 ft, to local automobile works, for production for Government. Superstructure will begin soon. Cost reported over $450,000. Giffels & Vallet, Inc., Marquette Bldg., Detroit, Mich., is architect and engineer.

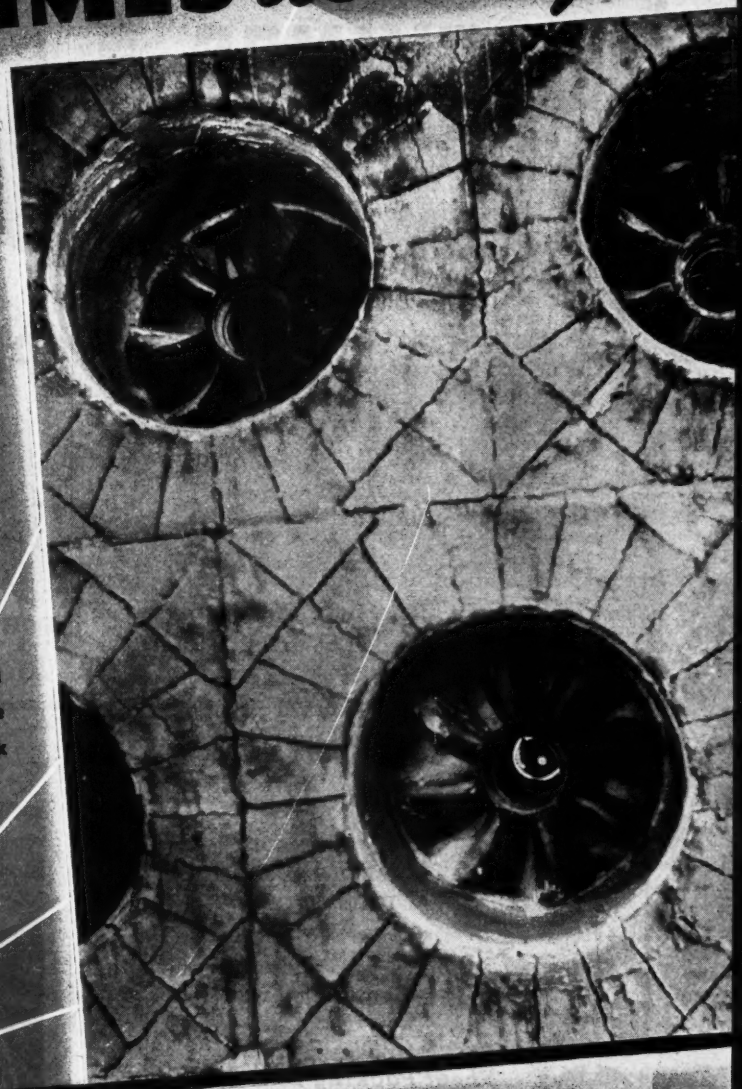
Wis., Plymouth—Plymouth Electric and Water Utilities Department has tentative plans under way for extensions and improvements in boiler house at municipal power station. Also for installation of electric equipment, including new voltage regulator unit. Project will be a postwar development. Estimates of cost will be made soon.

Wyo., Laramie—Bureau of Mines, Department of Interior, Washington, D. C., plans installation of electric power equipment in new two and three-story shale laboratory and research building, 45x180 ft, on campus of University of Wyoming, Laramie. Cost estimated over $600,000, with equipment. Proposed to ask bids in December, when plans will be completed. Frederic H. Porter, 2118 Central Ave., Cheyenne, Wyo., is architect. H. P. Rue is Bureau engineer in charge at Laramie.

When BURNER RINGS last 3 TIMES as long...

The service they went through was terrific—24 hours a day . . . 7 days a week . . . no let-up . . . plus capacity . . . full head of steam . . . no time for shut-down. They took the punishment . . . they delivered. When burner rings last 3 times as long under that kind of service, look to the engineering.

The unretouched photograph here shows a set of burner rings—Detrick Burner Rings that have been in use three times the normal span of life for burner rings. Performance like this is visual evidence of the soundness of Detrick engineering—practical engineering that knows materials and how to use each for its best function. In this case the principle of sectionalizing and individually suspending the tile is responsible for the long life of the rings and the Detrick Wall and Arch that went with them.



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Now is the time to get your post-war plan on the boards. Let us look over your blueprints and make suggestions for improvements, and modernizing that can be made in the immediate future, providing greater capacity or higher efficiency from your present equipment. Detrick Suspended Walls and Arches will continue to give plus service in peace time as they have before and during the war, adding to the lives of furnace enclosures and saving money for their owners. Ask for our new catalog "Detrick Furnace Enclosures."

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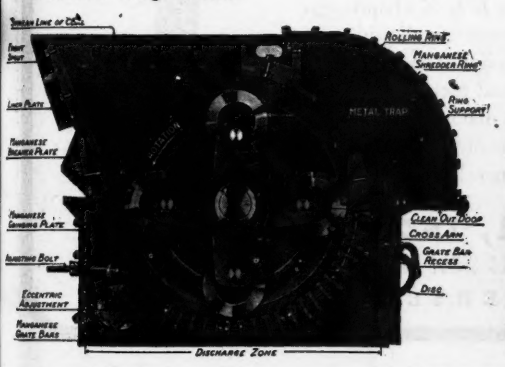
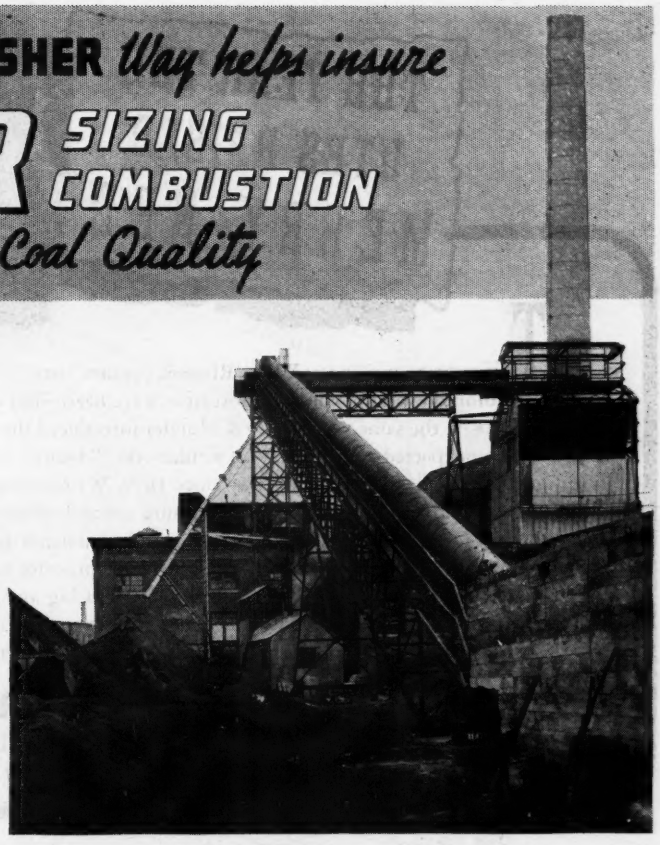
The AMERICAN CRUSHER *Way helps insure*

BETTER SIZING COMBUSTION

Regardless of Coal Quality

Below: Cross-sectional view of American Ring Crusher.





YOU may not know what sort of coal is going to be delivered to your bunkers from day to day. But you can be sure of better sizing and better combustion if you prepare coal the simplified AMERICAN Crusher Way.

Coal entering the AMERICAN Ring Crusher from the top, falls on and is struck by rings in suspension. This action of the rings—shattering and distributing the coal before it reaches the breaker and grinding plates—is the "inside story" of AMERICAN Crusher economy.

In one operation, run-of-mine or lump coal is reduced to required sizes for unit pulverizers and automatic stokers. Many plants report that this coal preparation is done at a total cost of less than a penny a ton, including maintenance, power, labor, depreciation and interest on investment.

Benefit By Guaranteed Performance

The many money-saving installations of AMERICANS in industrial plants, central stations and service establishments are the result of the thoroughness with which our engineers study individual plant requirements before making a recommendation.

On the basis of our recommendations, AMERICAN Crushers are guaranteed for definite performance. Let us cooperate with you in getting better sizing and lower steam costs with your coal supply.

Right: Patent shredder rings split coal in uniform size instead of crushing it — a patented "American" feature.

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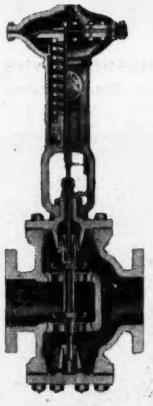
THE INDIAN uprising at White River in the new state of Colorado was unexpected. Hostilities were fierce—but quickly quelled. That was 1879, the same year Kieley & Mueller introduced the steam trap. This too, was unexpected—an entirely new idea—the "daddy" of all traps. Control equipment has come a long way since 1879. Witness the K & M Diaphragm Motor Valve, for supersensitive pressure control of steam, oils, liquids, gas or air. Designed for use with air-operated instruments or auxiliary pilot units —in models to meet every condition of flow, pressure and temperature. Patented special features assure minimum friction lag and maximum efficiency. Type 484 is only one of more than 100 K & M precision control devices which benefit from our 64 years of specialization. Write for general Catalog No. 66.



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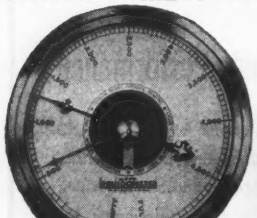

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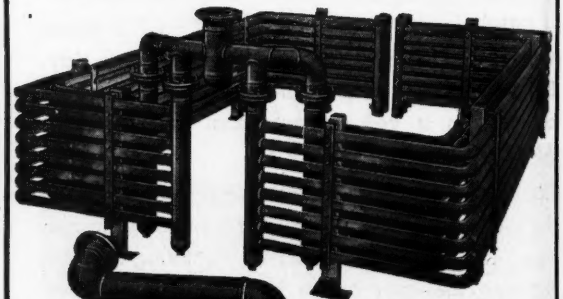

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The vigilant "eye" of Photoswitch photoelectric control scans the smoke, never relaxing for a second its 24-hour watch over your fuel budget. Conditions of excess smoke, normal combustion, and excess air are thus detected *electronically* and reported to the boiler room by means of visual or audible signals, Ringelmann-calibrated meter readings, or permanent chart recordings. The result — a co-ordinated, complete system for checking overall combustion efficiency — simple, dependable and inexpensive to install and to operate.

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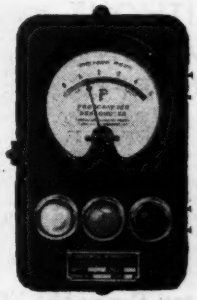
Photoswitch is putting electronics to work — today — maintaining boiler water levels automatically . . . controlling levels in condensate return systems . . . detecting contamination in condensate . . . preventing explosions caused by flame failure . . . checking turbidity in liquids . . . timing for split-second repeat-cycle accuracy. Let us recommend the modern electronic solution to your control problem.



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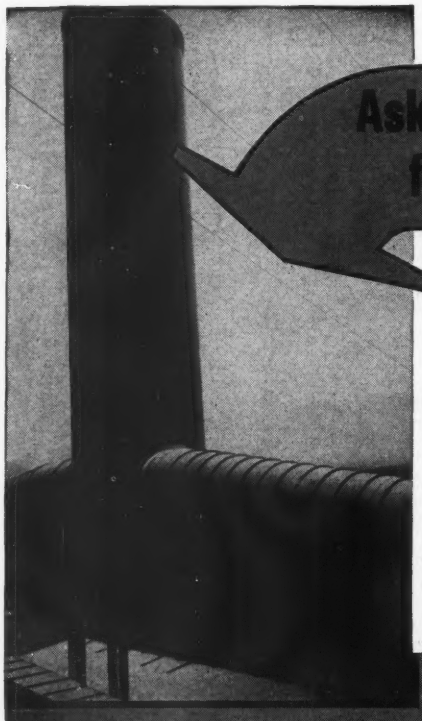

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WE take pardonable pride in the fact that 100% of Connery output is going to war production projects. And we feel certain that the many plants using (and planning to use) Connery's Improved Expansion Stiffened Construction for stacks, breechings, ducts, etc., won't mind if we give our best to "our first customer," Uncle Sam.

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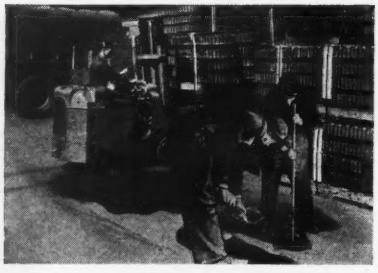
WITHOUT HALTING TRAFFIC



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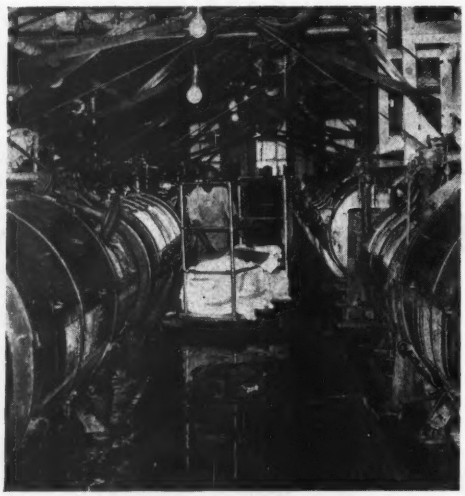

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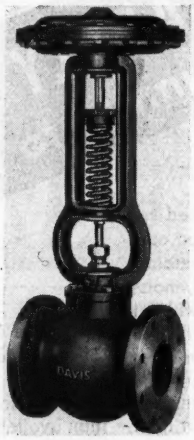
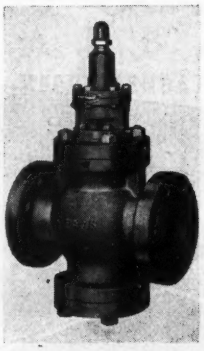
PISTON ACTUATED—Direct Acting	✔											✔	✔	✔		✔			
AUXILIARY PILOT CONTROL		✔					"	✔	✔	✔	✔	✔			✔	✔	"		
SPRING LOADED			✔	✔										✔			✔	✔	
WEIGHT LOADED	✔	✔			✔	✔	✔					✔	"	✔	✔	✔	✔	✔	
SERVICE: GENERAL SERVICE	✔	✔		✔	✔	✔													
SERVICE: LOW PRESSURES—Heating	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔			✔	✔	
SERVICE: HEAVY LOAD DEMANDS		✔			✔	✔					✔								
SERVICE: SPECIAL SERVICE		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔					
RANGE OF SIZES	¼ to 24	4 to 24	¾ to 2	¾ to 24	¾ to 24	¾ to 24	¾ to 24	¾ to 24	¾ to 2	¾ to 24	¾ to 2	¾ to 24	¾ to 24	¾ to 24	4 to 8	¾ to 2	2 to 24	¾ to 24	¾ to 24

...consult DAVIS



Above—No. 14 Direct connected spring loaded regulator. For steam, air, gas, water, oil. For pressures to 400 psi. For reduced pressures 0 to 200 lbs.



Above—No. 40 for heavy duty, variable load conditions. Unaffected by high pressure fluctuations. Self-contained. Pilot operated. For pressures to 400 psi.

The variables encountered in the application of pressure regulators are so numerous that they make selection of the proper regulator a tough job at best. Yet, because choice of the proper types of regulator determines to such a very great extent the efficiency of the installation, it is essential that the job of selection is not slighted. To help you choose the proper regulator, Davis offers a number of helps:

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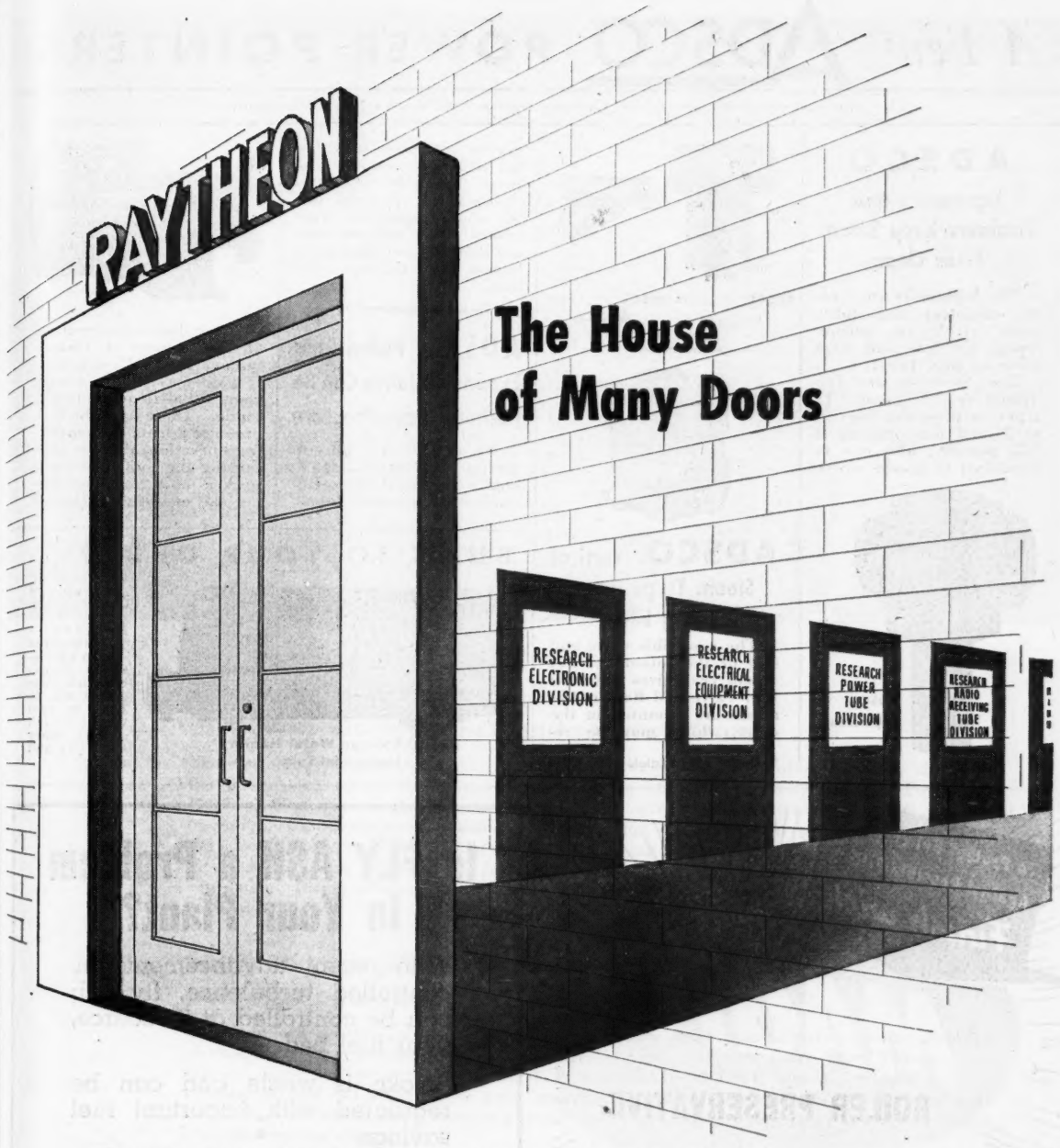

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Separators and Strainers Keep Steam Lines Clean

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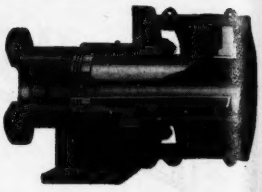

These joints incorporate all the features of Adsco's famous internally-externally guided type plus piston rings fitted in the internal guide. These hold the line pressure during the repacking operation, thereby permitting the joint to be unpacked and repacked under full operating pressure.

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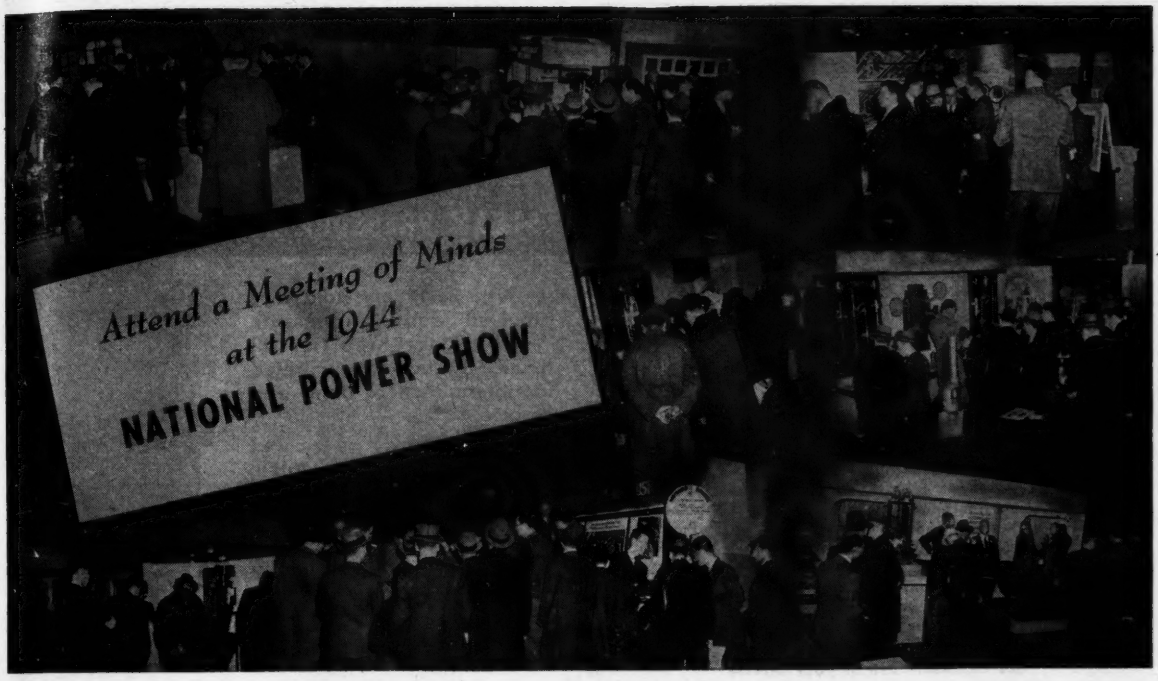

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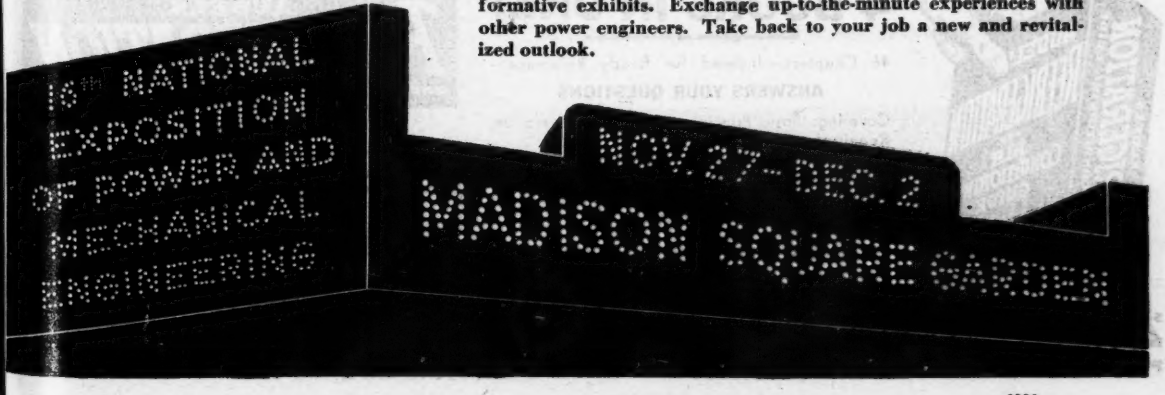

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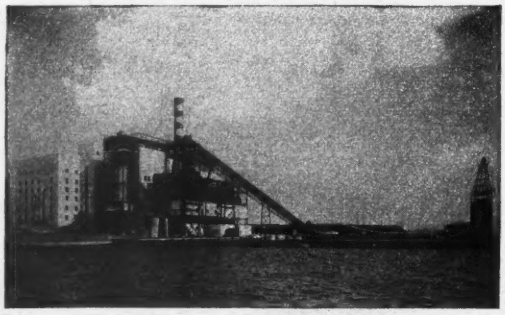

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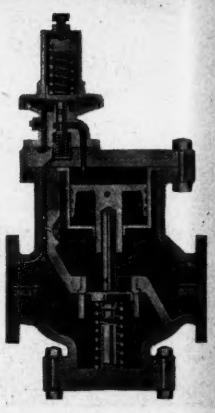

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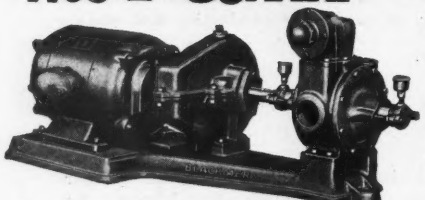

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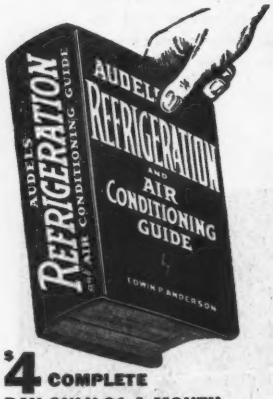

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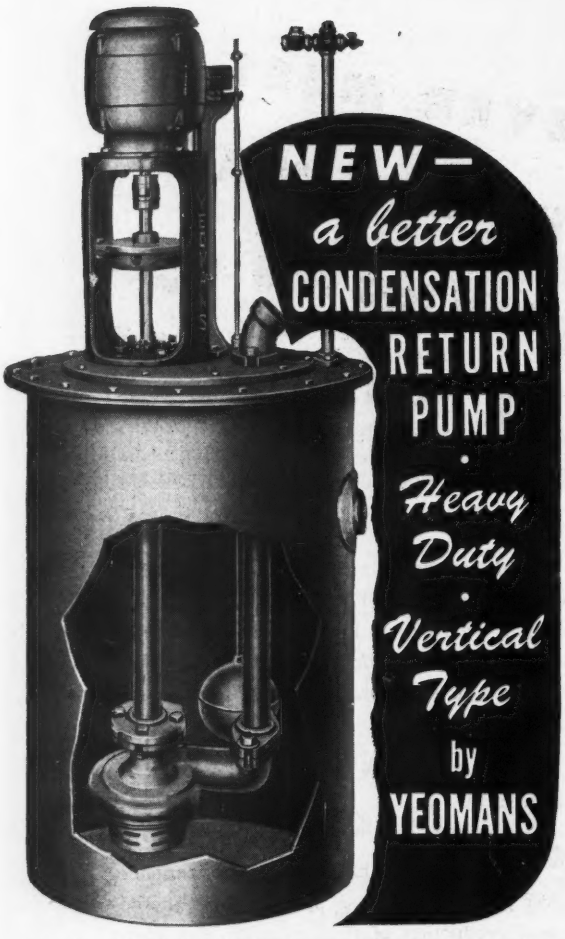

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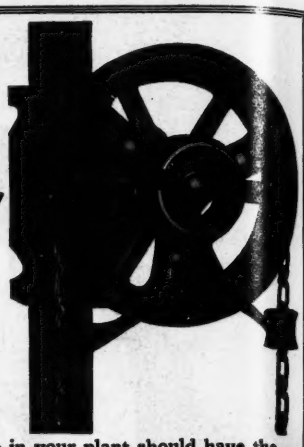

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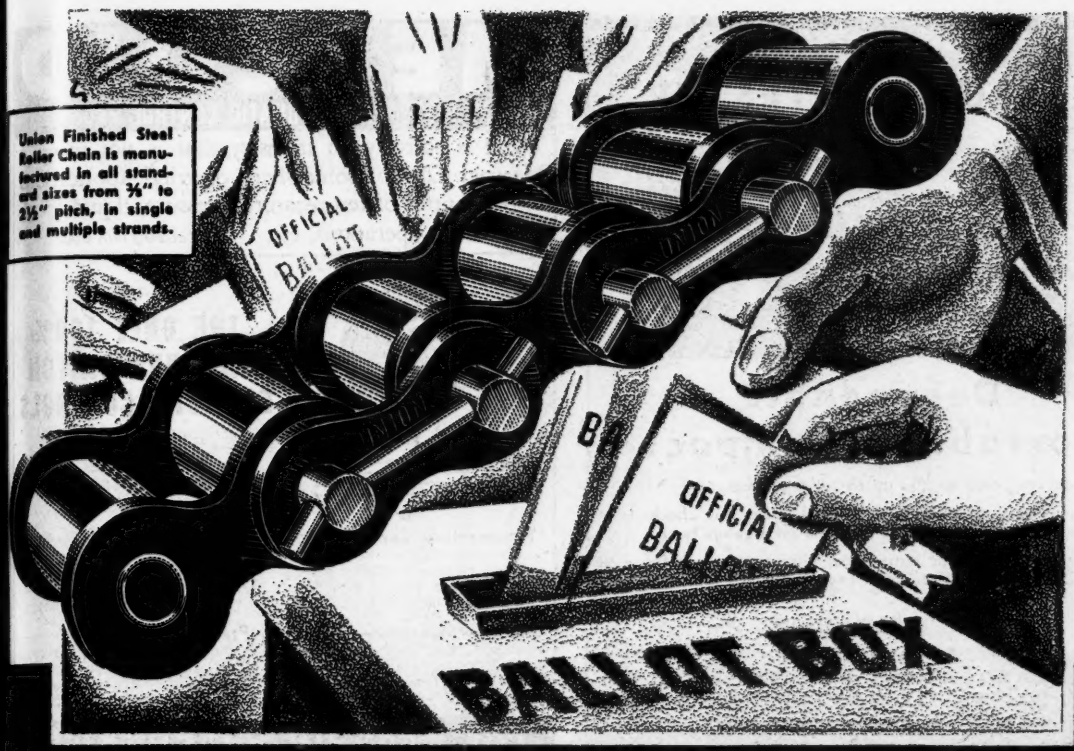
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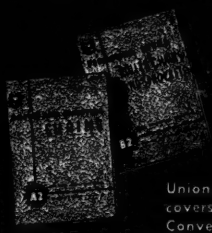

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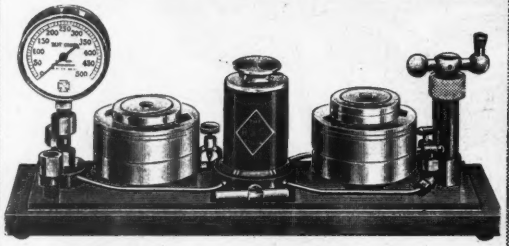

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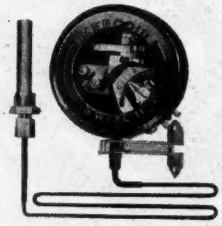

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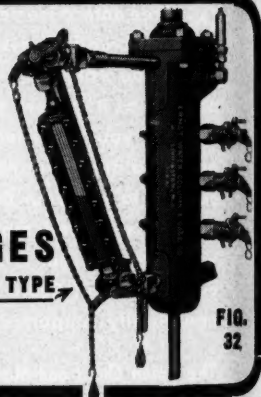

FIG. 32

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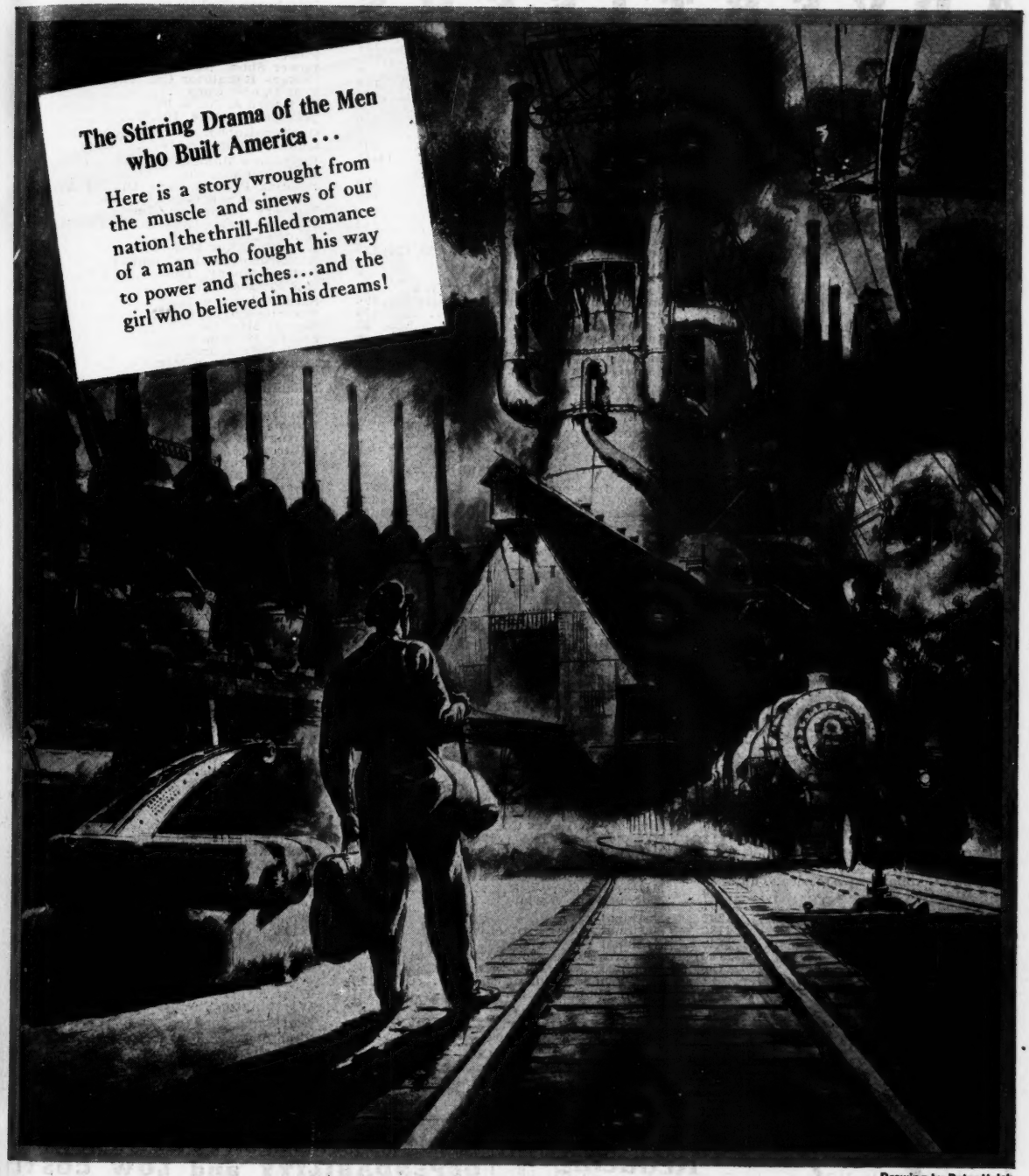
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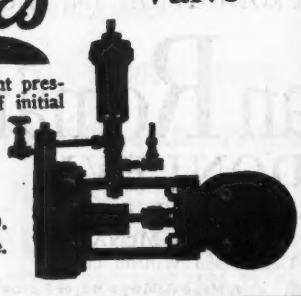

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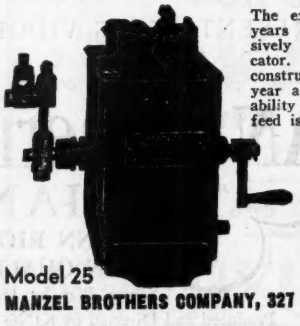

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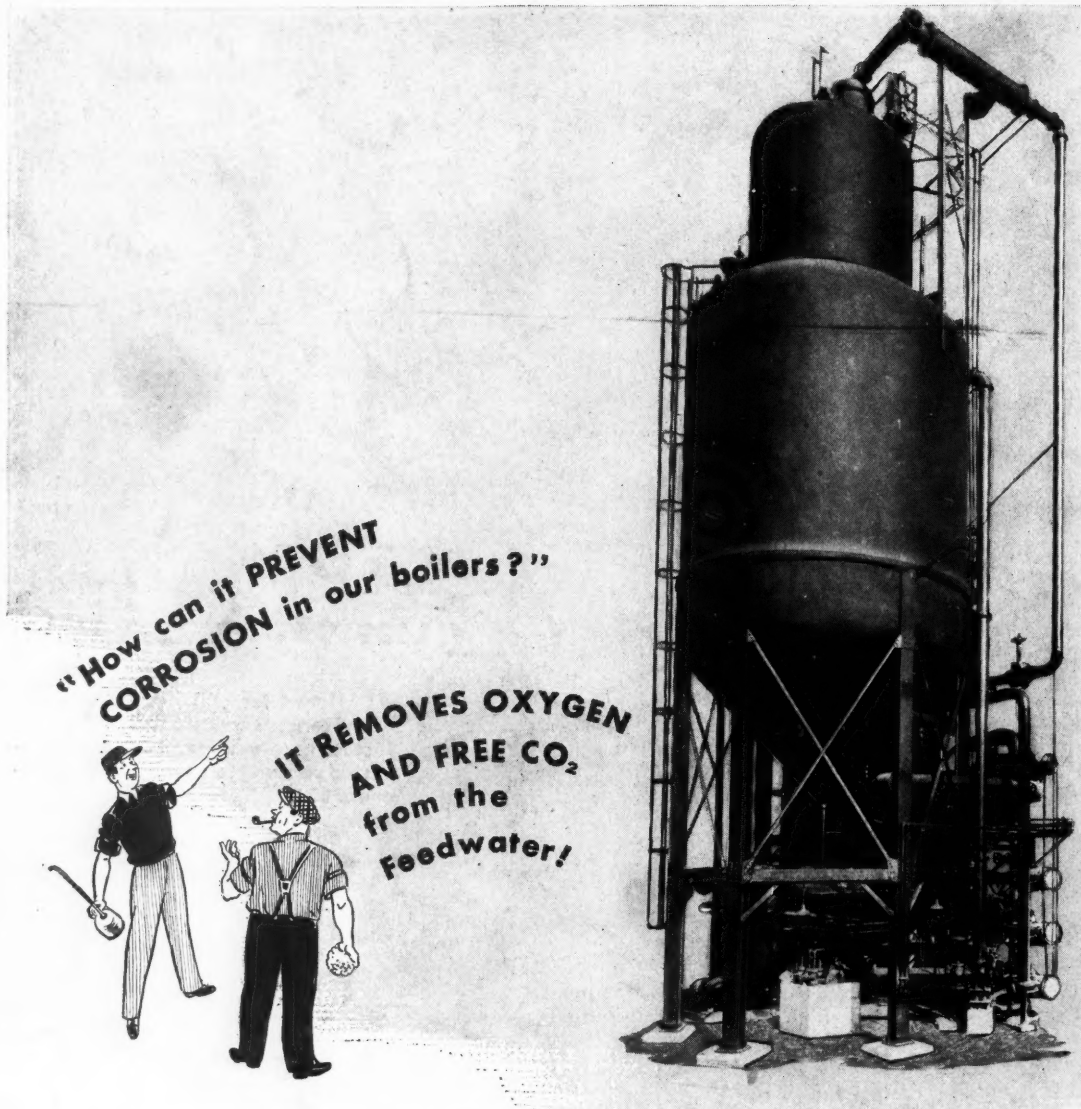

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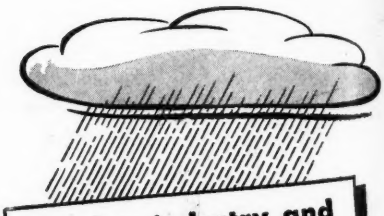

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